TEXTILE RESEARCH JOURNAL

VOLUME XXIII May, 1953 *NUMBER 5*

Annual Review Issue

PUBLICATION OF

TEXTILE RESEARCH INSTITUTE

Editorial Office: 10 East 40th Street, New York 16, N. Y.

Rayon Reports

Prepared Monthly by American Viscose Corporation, New York, N. Y. MAY, 1953

Study reconfirms launderability of rayon shirts of vat-dyed fabrics stabilized with Avcoset

Twenty consecutive launderings of white, cream, and yellow spun rayon shirts that had been treated with the Avcoset process, have clearly proved their commercial launderability.

This was the finding of a study conducted on 36 shirts at the College of Household Arts and Sciences, Texas State College for Women. The study was made under a Textile Research Fellowship sponsored by American Viscose Corporation.

The strength, dimensional change, and color retention values of the shirts were measured after 5, 10, 15, and 20 launderings.

Dry strength changes in the warp direction ranged from 7.5 to 26.2 per cent after 20 washings. In the filling direction changes ranged from 6.8 to 22.7 per cent. No rupturing nor visible damage occurred during the washings.

Dimensional changes, by Commercial Standard CS59-44, showed no positive or negative change greater than 1 per cent. Higher shrinkages noted in the seams were attributed to the thread used and the amount of tension applied during commercial laundry pressing procedure.

After the washings, plus ironings, the number of units of color difference in the cream shirts was 5.87, and in the yellow shirts, 3.50. Whiteness retention was 100 per cent throughout.

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TEXTILE RESEARCH JOURNAL, published monthly at Prince and Lemon Streets, Lancaster, Pa., is devoted to the interest of research in textile and allied industries. It is published by Textile Research Institute.

Manuscripts and communications should be sent to the editorial office, 10 East 40th Street, New York 16, N. Y.

Subscription rates:
$15.00 per year; additional for postage, 50 cents to Canada, $1.00 to all other countries. Single copies, $1.50 each.

Entered as second-class matter, April 27, 1945, at the post office at Lancaster, Pa , under the Act of August 24, 1912. Accepted for mailing at special rate of postage provided for in paragraph (d-2), Section 34.40, P. L. & R. of 1948, authorized May 9, 1950.

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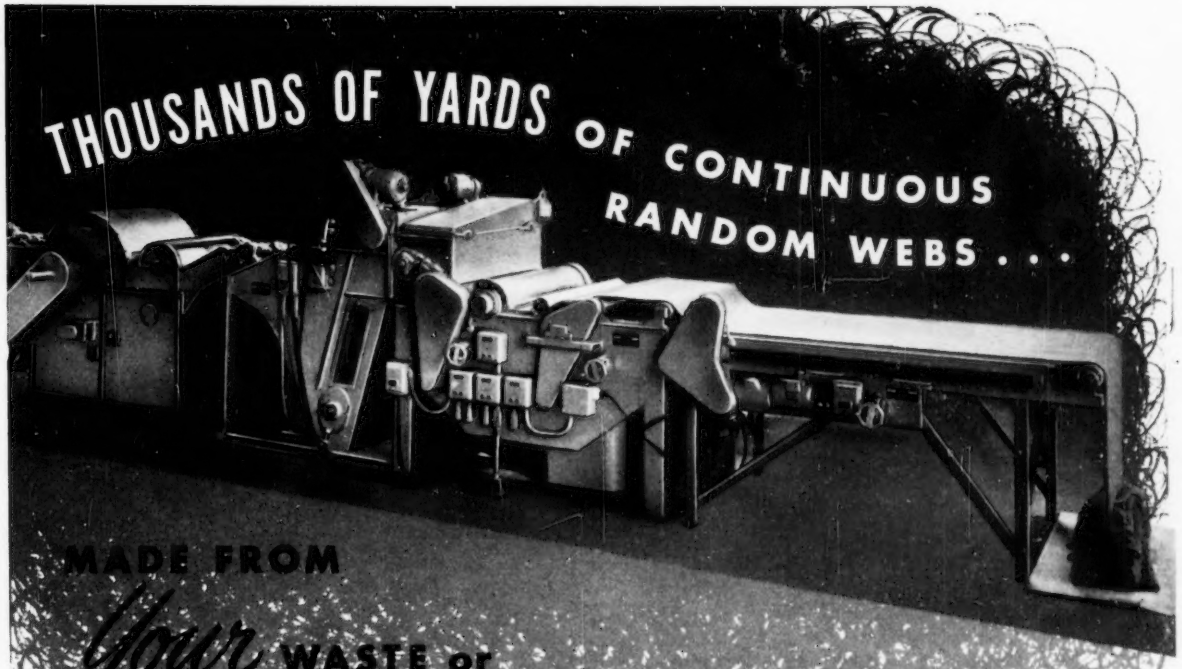

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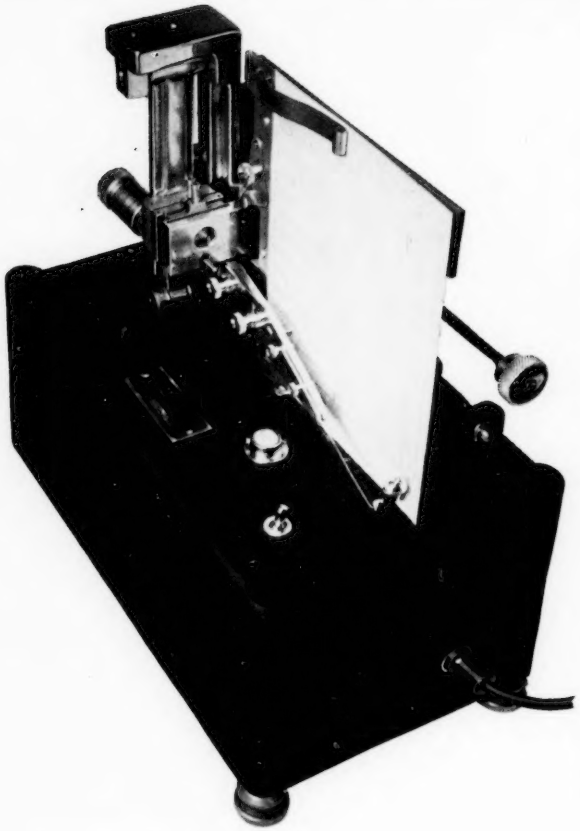

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TEXTILE RESEARCH JOURNAL

VOL. XXIII, No. 5 May, 1953

THE NEW SYNTHETIC FIBERS

A SYMPOSIUM*

Introduction

by Frank J. Soday, Chairman†

Few developments of modern times have affected mankind as profoundly as synthetic fibers. While the need for such fibers had long been recognized, the inventive genius and the manufacturing skills of the present century were required for their production.

The brilliant British physicist Robert Hooke predicted the eventual development of artificial silk in 1664. Recognizing that the basic problem was the provision of a suitable "artificial glutinous composition . . . much resembling that out of which the silkworm wiredraws his clew," he stated that "if such a composition were found, it were certainly an easy matter to find very quick ways of drawing it out into small wires for use . . . I need not mention the use of such an invention, nor the benefit that is likely to accrue to the finder, they being sufficiently obvious."

While we may question Hooke's designation of the development of suitable spinning techniques as an "easy matter," his procedure still serves as a blueprint for the development of new fibers. Then, as now, the problem resolved itself into the basic steps of (*1*) providing a composition having the desired physical and chemical properties, and (*2*) shaping the composition into filaments of the required size and shape.

Despite this promising beginning, very little progress was made during the next two centuries, primarily because the science of chemistry had to advance to the point at which it could supply the "artificial glutinous composition" required by Hooke's process. In 1883 Weston produced experimental filaments from an ether-alcohol solution of cellulose nitrate, and shortly thereafter Swan found that the product could be denitrified, thus regenerating the cellulose, by the action of ammonium sulfide. The stage was thus set for the production of an artificial fiber, although the basic raw material had been provided by nature's marvelous photosynthesis process instead of in the chemist's test tube.

Count Chardonnet then bent his keen mind to the task in the closing years of the century. A chance observation of a spaghetti machine extruding a plastic mass in the form of large filaments led him to the conclusion that a synthetic fiber could be produced if a solution of the proper composition were forced through minute orifices. After many false starts, the

* Presented at the 119th Annual Meeting of the American Association for the Advancement of Science in St. Louis, Mo., Dec. 27, 1952.

† Director of Research, The Chemstrand Corp., Decatur, Ala.

Weston-Swan process for the regeneration of cellulose was adopted, with promising results. This led to the construction of the first plant for the commercial production of "artificial silk" or rayon, at Besançon, France, in 1891.

Rayon was produced initially in this country in 1911, and by 1938 it was second only to cotton in terms of annual consumption. Present consumption of rayon and acetate is at the rate of 1¼ billion pounds per year, equivalent to approximately 20% of our total fiber requirements.

Further developments in chemistry made it possible to attempt to duplicate nature's work in constructing large molecules from single basic materials. In 1927 the Du Pont Company inaugurated a fundamental research program which was to result in the first true synthetic fiber, one composed of molecules entirely formed by man according to a prearranged pattern, starting with chemical raw materials.

Nylon, the product of this development, was placed on the market in 1939, and quickly displaced silk in hosiery and fine garments. It is regarded by many textile experts as the outstanding fiber among all natural and synthetic fibers. Hooke's prophecy had been fulfilled.

Encouraged by the warm reception accorded nylon, the textile industry requested additional synthetic fibers possessing new and unusual properties to satisfy the consumer demand for garments having improved styling, comfort, and durability standards. Orlon, Acrilan, Dynel, Dacron, and other synthetic (or chemical) fibers have been developed with bewildering rapidity during the past few years in response to this demand. And the end is not in sight, as many other synthetic fibers, such as X-51, nylon 6, and M-24, are in various stages of development and may be expected to be available in commercial quantities in the near future.

The United States has not been alone in this respect, as important developments have also been made abroad in the field of synthetic fibers. The development of Terylene in England, Perlon and Redon in Germany, and Rhovyl in France have been outstanding contributions.

Synthetic fibers are derived almost entirely from natural gas, petroleum, coal, limestone, salt, and other readily available raw materials. Man is thus turning increasingly from agricultural products to minerals for his clothing.

This trend is timely, for synthetic fibers are required in ever-increasing quantities for clothing due to increasing competition between food and fiber crops for available land. At the time of Hooke's prophecy, there were approximately 400 million people in the world, and new land was available for cultivation in apparently unlimited quantities. Today, the world population is approximately 2¼ billion, and it is increasing at the rate of 1% per year. This increase in population has been accompanied by an equally rapid decline in the amount of land adapted to food and fiber production due to erosion, improper use, and overcultivation. The available arable land on the globe is now estimated at not more than 2½ billion acres, or slightly more than one acre per person. The production of foodstuff in sufficient quantities to meet minimum world requirements is becoming an increasingly difficult task.

The total world fiber consumption during the past few years has tended to outrun production. In fact, the supply of natural fibers would have been inadequate for this purpose if substantial quantities of semisynthetic and synthetic fibers had not been available. Thus, the world production of the four principal textile fibers—cotton, rayon, wool, and silk—was 18¼ billion pounds in 1950, which is identical with the production of the same fibers in 1936. This represented a decline in the production of natural fibers, as the production of rayon had increased from ¼ to 3½ billion pounds during the same period. Without this increase in rayon production, we would be facing a serious fiber shortage today.

Cotton production in this country appears to be leveling off at 15 million bales per year. Despite every inducement by the U. S. Department of Agriculture to produce 17 million bales in 1951 and 16 million bales in 1952, only 15 million bales were ginned each year. This could develop into a serious situation if synthetic fibers were not available, as population growth will increase our total fiber requirements in the apparel and household fields alone by the equivalent of a million bales every 4½ years.

The wool industry is faced with an even more serious problem. Since the end of World War II, world wool consumption has exceeded wool production by 1½ billion pounds.

In 1870 there were as many sheep as there were persons in this country—40 million of each. By 1950, the human population had increased to over 150 million, while the sheep population had declined to 28 million.

The production of domestic wool has been declining for the past decade, and is now 40% less than it was in 1942. As a result, the major portion of our wool requirements must be imported. In 1950, we consumed 636 million pounds of wool, but produced only 230 million pounds.

The future growth of the synthetic fiber industry in this country depends largely upon (*1*) population growth and (*2*) the availability of land for agricultural purposes. With respect to the first item, our population is increasing at the rate of 7,400 per day, or 2¾ million per year. It is estimated that approximately 2½ acres of land per person are required to maintain our present standard of living, and by 1955 there will be less than this amount available. Some 120 million more acres of land suitable for agricultural purposes will be required by 1975, of which only 30 million can be obtained by drainage, irrigation, and clearing. This difference must be met by increasing the yields of food crops per acre and by increasing dependence upon nonagricultural sources for fibers.

The total consumption of fibers in this country in 1952 was 6.5 billion pounds, equivalent to a per capita consumption of 40 pounds. This includes 27 pounds of cotton, 9 pounds of rayon and synthetic, and 4 pounds of wool. At this rate of consumption, 100 million pounds of additional fibers will be required each year to meet the needs of our growing population. Additional amounts undoubtedly also will be required to take care of the increasing per capita consumption of fibers, which increased from 20 pounds in 1930 to 30 pounds in 1940 and 40 pounds in 1950.

Synthetic fiber consumption in this country in 1952 amounted to 275 million pounds, equivalent to approximately 4% of all fiber consumed. Synthetic plus rayon consumption amounted to 23% of the total.

The President's Materials Policy Commission forecasts the production of 975 million pounds of synthetic fibers in 1960 and 4 billion pounds in 1975. The latter will include 1.2 billion pounds of acrylics, 1 billion pounds of polyester fibers, 1 billion pounds of miscellaneaous synthetic fibers, and 800 million pounds of nylon. Rayon production will have increased to 3 billion pounds by 1975. The proportionally greater dependence upon synthetic fibers than upon rayon to supply the needs of the country at that time is based on the increasing difficulties that will be encountered in obtaining the required cellulose, an agricultural product which will compete with food crops for the dwindling per capita land supply.

A consideration of these figures will indicate the vast expansion which must take place in our economy to secure an adequate supply of fibers in the years to come. The textile producing and processing industries now consume approximately 25% of all of the industrial chemicals produced in this country, and this percentage undoubtedly will increase as more of our fiber requirements are obtained by the use of chemical raw materials. The capital investment per pound of annual staple production is estimated to be $1.00 to $1.50, while the capital investment per pound of annual filament production is approximately $2.00 to $2.50. It is estimated that 40 million dollars is required to place a new fiber on the market on a plant-scale operation basis, and 150 million dollars is required to construct a fiber plant for the production of 50 million pounds of fiber per year, including the cost of the auxiliary plants for producing the chemical raw materials.

The 1930's saw the rise of the synthetic organic chemical industry in this country, while the next decade witnessed equally impressive developments in synthetic rubber and plastics. The present decade is destined to be one in which synthetic fibers will play the outstanding role. At the present time, the synthetic fiber industry exceeds all other branches of the chemical industry in rapidity of growth and possibilities for the future.

Technical Developments Leading to Present Man-Made Fibers

Joseph B. Quig*

THE progressive industrialization of the world calls for functional fibers, as it has for functional metals, plastics, paints, dyes, and other materials. The future of man-made fibers hinges upon this concept. It is certain that success will come to those fibers possessing the greatest measure of useful distinctiveness and the most favorable relationship of performance to cost.

For a quarter of a century, research on man-made fibers had been dominated with the idea of duplicating the natural fibers, especially silk and wool. A significant change, simple in concept, then occurred. Harold DeWitt Smith prophetically gave the industry the objective for its next stage of development in the 1944 Edgar Marburg Lecture [4]. He said, "The essence of this new philosophy is that fibers can be designed to meet specific textile wants, rather than designing textile wants to utilize immutable fiber personalities. . . . There is a wide and exciting horizon of the future, in which the only real limitations in the variety and characteristics of textile fabrics yet unborn will be the ability of the textile designer and technologist to help the fiber manufacturer understand what kind of fibers are wanted."

Historically, the concept of producing fibers with definite functional properties was being put to use in rayon research in the year 1930. A study of the criteria of fibers for automotive tires and various industrial uses indicated that a suitable fiber must possess high tensile strength, toughness, fatigue-resistance, and the capability of being made into a thinner, more flexible reinforcement for rubber. In 1934, engineering and chemical research of the DuPont Company, directed to satisfy these specific textile needs, yielded "Cordura" high-tenacity rayon for tires and other industrial uses. High-strength rayon was proved by the engineers of the rubber companies to make the best heavy-duty tire cords for military vehicles during World War II, and these functional rayon tire cords now dominate the market for both trucks and passenger cars.

This development was not only timely from the standpoint of satisfying the technical requirements of the automotive industry, but it also created an awareness of the need for fundamental research in the manufactured fibers industry. It not only confirmed the philosophy of fiber research so clearly enunciated by Smith, but it also stimulated the initiation of research, with the objective of finding high polymers other than cellulose and proteins.

Early Search for Fiber Raw Materials

For some time it had been recognized that polymers other than those produced by nature would be necessary to extend the frontiers of the fiber industry. Many illustrations citing the limitations of fibers from natural polymers could be given. For example, rayon and acetate had been unusually successful in the lingerie and dress field, but it was the consensus that rayon hosiery for women was unsatisfactory because of insufficient elastic recovery and durability. Research was first directed to a study of the derivatives of cellulose, particularly the ethers and new types of esters. These materials, although capable of being spun into yarns, appeared to offer no significant advantages in properties or cost compared with know types of rayon and acetate fiber.

During the course of this investigation, certain nitrogen-containing derivatives of cellulose were prepared with the thought that amino or substituted amino groups would modify the properties of cellulose, particularly its dyeing characteristics, and in this respect make it approach silk and wool more closely. This investigation was unsuccessful, but it did serve to highlight three important points concerning natural polymers. First, the supply of these polymers contains the factor of uncertainty inherent in nature. Second, in the chemical treatment of natural polymers—for example, cellulose—the chemist is usually limited chemically and physically by the

* Manager, Textile Research Division, Textile Fibers Department, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.

necessity of preserving the essential structural features of the starting polymer. Third, knowledge was needed on how simple molecules are joined together to form polymers.

The Rise of Aliphatic Chemistry

The chemical progress of our century has made possible the synthesis of new fibers, just as the industrial revolution in the nineteenth century stimulated the use of cotton. In 1800 only 4% of the world's textile fibers consisted of cotton, 18% being flax and the remainder wool. The development of new machinery favored the use of cotton as a cheaper raw material in those uses for which its properties were suitable. As a result, cotton became king and the consumption of wool dropped from 78% to 13%. Yet, in spite of this, the consumption of wool did not diminish in pounds, but only in percentage.

The rise of aliphatic chemistry, which provided the means for synthesizing intermediates and monomers economically, made it possible for research to consider high polymers seriously. For example, vinyl chloride and its polymers must inevitably have remained laboratory curiosities until the chemistry of acetylene and ethylene was sufficiently advanced to make their use practical on an industrial scale. Polyethylene remained undiscovered until the means of examining and controlling reactions under very high pressures had been found.

Thus, rapid industrial developments, including that of man-made fibers, preceded and were responsible for the momentum that high-polymer chemistry has displayed in recent years. Today, synthetic high polymers form the basis of three industries of growing importance—namely, plastics, synthetic rubbers, and synthetic fibers. These three industries have a common scientific background based on synthetic polymers, but have different requirements for the basic raw materials and different technologies of application. The intermediates and monomers used in synthesizing polymers for fibers must be easily available and of low potential cost, the polymerization process must be relatively free from side reactions, and the conversion of the polymer into a textile fiber must involve a process that is economic and easily workable. The combination of these requirements demands a thorough knowledge of chemical production, high-polymer chemistry, chemical and mechanical engineering, and the multiple needs of the textile industry.

Principles of Fiber Formation

Until 1920 there was no generally accepted idea of what constituted a fiber-forming molecule. Staudinger, Meyer, Mark, Astbury, and others, working with the x-ray method, showed conclusively that cellulose is crystalline and has a simple repeating pattern corresponding with the dimensions of a glucose unit. It was then possible to approximate the number of repeating units forming the macromolecular chain. Staudinger, working on the polymerization of formaldehyde, indicated that long polymer chains could be built up in a regular fashion from low-molecular-weight compounds, and that such polymers gave typical x-ray diagrams. The polymerization of vinyl compounds, such as styrene and vinyl chloride-vinyl acetate copolymers, also showed the possibility of making long-chain, high-molecular-weight polymers by the polymerization of simple organic compounds.

The vinyl chloride-vinyl acetate copolymers were introduced in the early 1930's by Carbide & Carbon Chemicals Co. under the trade-mark "Vinylite." Vinyl acetate was used in varying small amounts in these copolymers to make them soluble in simple solvents like acetone. Because of their low cost and easy solubility, these copolymers quite naturally attracted attention as fiber-forming candidates for the solvent or dry spinning process that was already well developed for cellulose acetate. The resulting fiber, trade-marked "Vinyon," was introduced by American Viscose Corp. in 1938, the year that nylon was also introduced. Although "Vinyon" had excellent resistance to chemicals, it had some serious limitations for wearing apparel—particularly a low softening point and excessive shrinkage at temperatures normally encountered in pressing operations.

Polyvinyl chloride fibers were produced on a small scale in Germany at the same time by the I. G. Farbenindustrie [5]. In order to overcome the restricted solubility in organic solvents, the polymer was chlorinated to impart solubility in acetone; and it was then formed into a fiber by a modification of the well-known wet spinning process. The fiber, known as "PeCe," had the same limitations as "Vinyon." The fiber-producing plant, which is now in the Russian zone, is believed to be inactive and probably will not be reactivated.

In 1927 W. H. Carothers had begun a program of fundamental polymer research at the DuPont Experimental Station. His classical researches [1] into the mechanism of the formation of high polymers gave an

insight into the theory of the production of linear polymers from simple structures—on the one hand, by the simple conversion of a monomer into a polymer by addition polymerization, consisting simply of the union of several molecules with a redistribution of the valency bonds but with no splitting off of simple chemical substances; and by condensation, in which several monomeric units are joined together by the elimination of one structural unit, such as water, hydrochloric acid, and ammonia. In his work on condensation polymers, he avoided the unnecessary complications produced by branched and cross-linked chains. To this end, he synthesized linear polymers from bifunctional intermediates, preparing first a series of polyesters. The aliphatic polyesters were closely examined as a class, and were found to be low melting and susceptible to hydrolysis. This and other work on polyanhydrides and polyacetals led him to the polyamides containing nitrogen groupings similar to natural silk and wool.

Carothers prepared polyamides from a variety of amino acids and also dibasic acids. Early in 1935 —now a historic date—the high polymer from hexamethylenediamine and adipic acid was first synthesized:

$$n\mathrm{NH_2(CH_2)_6NH_2} + n\mathrm{HOOC(CH_2)_4COOH} \rightarrow \mathrm{H[{-}NH(CH_2)_6NHCO(CH_2)_4CO{-}]_n} + (2n-1)\mathrm{H_2O}$$

66 nylon

TABLE I. DIFFERENT TYPES OF POLYCONDENSATES PREPARED BY CAROTHERS [3]

Type	Linking group	Intermediates used in preparation	Remarks
Ester	—CO O—	Hydroxy acid Acid + glycol	Fiber-forming
Amide	—CO NH—	Amino acid Acid + diamine	Fiber-forming
Thioamide	—CS NH—	Aminonitrile + H_2S Diamine + dinitrile + H_2S	—
Urethan	—O CO NH—	Diisocyanate + glycol Dicarbamate + glycol	Fiber-forming
Thiourethan	—S CS NH—	Diisothiocyanate + dithiol	Not fiber-forming
Urea	—NH CO NH—	Diisocyanate + diamine Diurea + diamine Urea + diamine	Fiber-forming
Thiourea	—NH CS NH—	Diamine + trithiocarbonate Diamine + NH_4CNS	Fiber-forming
Acetal	—C O CHR O C—	Glycol + acetal	Unstable, some fiber-forming
Thioether	—C S C—	Dithiol + dihalide	Fiber-forming
Sulfone	—C SO_2 C—	Oxidation of thioether polymer	Fiber-forming
Anhydride	—CO O CO—	Acid + acetic anhydride	Unstable, fiber-forming
Ether	—C O C—	Chlorohydrin + alkali Glycol + dihalide	Low molecular weight
Sulfonamide	—C SO_2 NH—	Diamine + sulfonic acid or halide	Brittle fibers
Hydrocarbon	—C—C—	Dihalide + Na	—

The resulting polymer was melt spinnable and readily oriented (these two processes are described in the next section) by cold drawing to give lustrous fibers of good strength and flexibility. This polymer has been developed commercially here and abroad as "66 nylon." It is so named because each of the bifunctional intermediates has 6 carbon atoms.

This period of early research was invaluable because it provided a basis upon which a number of clarifying principles of high-polymer chemistry and fiber formation were founded. It has become possible to list some of the requirements for an organic high polymer to attain fiber-forming properties: (*a*) The polymer must consist of very large molecules, with a molecular weight exceeding 10,000 and an average chain length of over 1,000 Å. (*b*) The polymer must be linear and must have a high degree of symmetry and no bulky side-groups, so that good orientation can be obtained. (*c*) The polymer must be capable of undergoing a high degree of orientation for the production of strong fibers. (*d*) The polymer chains must have a high degree of polarity, produced by evenly spaced polar groups in the chain, to give good intermolecular cohesion, which leads to high melting point and the ability to maintain induced orientation.

Hill recently published a table (shown as Table I) listing various condensation polymers prepared by Carothers and their fiber-forming properties.

Research on Conversion to Fibers

The great industrial developments in aliphatic chemistry, furnishing the fiber industry with suitable and potentially low-cost monomers, and the basic research elaborating the synthesis and structure of large molecules were followed by an additional development involving chemical, mechanical, metallurgical, and thermal engineering which has contributed greatly to the progress of the chemical fibers industry. This development embodies the conversion of polymers to fibers by melt spinning.

Although glass fibers had been produced by drawing out molten glass filaments and solidifying them, one of the great engineering developments is embodied in the development of the melt extrusion technique by the DuPont Company for producing organic fibers. The melt spinning process can be applied to the

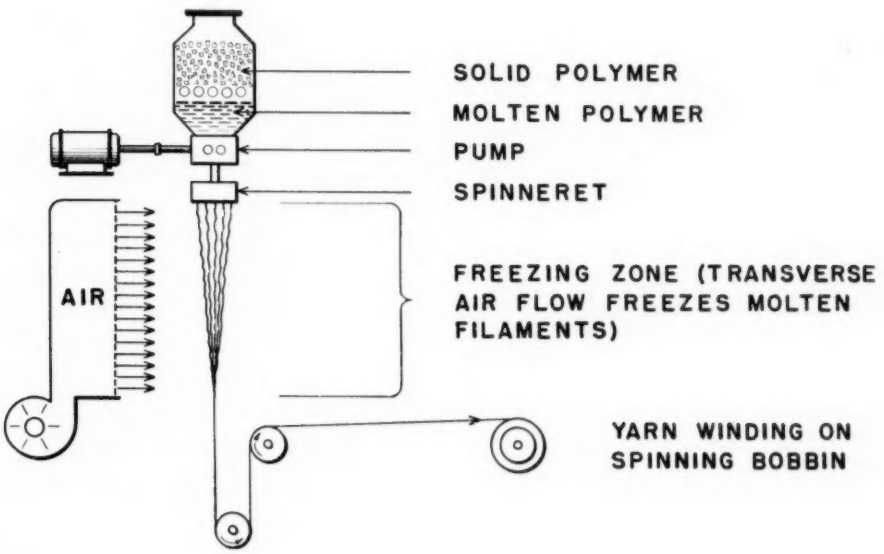


FIG. 1. *Nylon melt spinning scheme.*

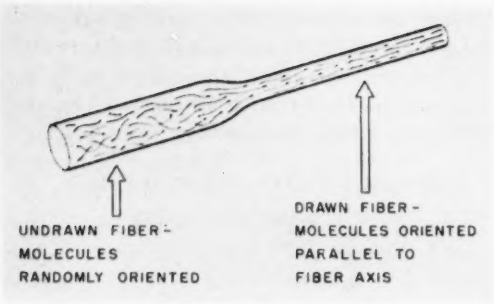


FIG. 2. *Orientation of nylon molecules by stretching fiber.*

production of filaments when the polymer is insoluble or not easily soluble in organic solvents and when the polymer will give, on melting, a viscous liquid without decomposition. Unlike the old processes of wet and dry spinning used for rayon and acetate, there is no problem of solvent recovery. In view of the higher temperatures used, the standard of engineering precision of the extrusion apparatus as a whole must be of high order and must be capable of producing filaments and fibers with the same tolerances in denier obtained by other methods of spinning, using solutions of relatively low concentration of the high polymer. Unquestionably, this engineering development has had and will have in the future a profound effect on the diversity of synthetic fibers.

Since it is undesirable to keep certain polymers in the molten condition for long periods, material in the form of chip is melted on a heated grid, from which the melt is delivered to the spinning pump at the desired rate and pumped through the spinneret. The issuing filaments are then cooled by a current of air, conditioned in steam, and wound onto a bobbin (see Figure 1). At this stage, the filaments are in the unoriented form and of comparatively low strength. The orientation necessary to develop the optimum physical characteristics is effected by drawing the yarn mechanically.

Drawing brings about a very desirable molecular change consisting of a gradual rearrangement of the long molecular chains from their unoriented, random arrangement to a definitely true fiber-oriented one (Figure 2). The long chains are lined up side by side, parallelized, and brought very close together. This makes it possible for strong intermolecular forces, if present, to come into play, so that attenuation is accompanied by a progressive increase in tensile strength. From a single polymer like polyhexamethylene adipamide or polyethylene terephthalate, it is possible, by varying the draw ratio, to prepare a family of fibers which differ among themselves in mechanical properties, from ones that are weak and limp to those that are strong and stiff, as shown in Table II.

TABLE II. PHYSICAL PROPERTIES OF NYLON AS A FUNCTION OF DRAW RATIO

Draw ratio	Temp. of drawing	Tenacity (g./den.)	Elongation (Suter) (%)	Moisture absorption 72% R.H., 78°F
2.51	Cold	2.2	160	4.67
3.45	Cold	3.1	89	4.52
4.47	Cold	4.6	50	4.29
5.01	Cold	5.8	36	3.90
5.38	Cold	6.6	22	3.75
6.07	Hot	8.2	21	3.54

Fiber-Forming Polymers

Rowland Hill in his paper on "Synthetic Fibers in Prospect and Retrospect" [3] brings to our attention that the discovery and development of synthetic fibers have not followed a single simple road, but have proceeded along two broad highways. First, there are polymer intermediates which were developed for non-fiber purposes—vinyl and vinylidene chlorides, originally produced commercially for plastics, and acrylonitrile for synthetic rubber—being appropriately polymerized to make them suitable for spinning operations and for fibers. Secondly, there are chemical intermediates, such as adipic acid, hexamethylenediamine, caprolactam, and terephthalic acid, substances which were formerly chemical curiosities, being produced exclusively because they provide fibers of unusual distinction and merit.

Looking at the problem broadly, there are a number of variables which must be considered when searching for fiber-forming polymers. The underlying requirements are: a satisfactory melting point, spatial symmetry, crystallinity, orientability, chain interaction, and chain stiffness. Chemical structure is determined by synthesis, while the physical structure is a result of the subsequent processes of drawing, annealing, and setting.

Linear Symmetry

Polymers having a three-dimensional or cross-linked structure, as exemplified by phenol-formalde-

TABLE III. EFFECT OF METHYL GROUPS ON FIBER-FORMING PROPERTIES OF POLYAMIDES [3]

Repeating unit	Crystallinity	Fiber formation	M.P.* (°C)
—CO CH_2 CH_2 CH_2 CH_2 CO NH CH_2 CH_2 CH_2 CH_2 CH_2 CH_2 NH—	yes	yes	265
—CO CH_2 CH_2 CH_2 CH_2 CO NH CH_2 CH_2 $CH(CH_3)$ CH_2 CH_2 CH_2 NH—	—	yes	180
—CO CH_2 $CH(CH_3)$ CH_2 CH_2 CO NH CH_2 CH_2 CH_2 CH_2 CH_2 CH_2 NH—	—	yes	216
—CO CH_2 CH_2 CH_2 CH_2 CO $N(CH_3)$ CH_2 CH_2 CH_2 CH_2 CH_2 CH_2 $N(CH_3)$—	no	no	−75
—CO CH_2 CH_2 CH_2 CH_2 CO NH CH_2 CH_2 CH_2 CH_2 CH_2 CH_2 $N(CH_3)$—	yes	—	145
—CO CH_2 CH_2 CH_2 CH_2 CO O CH_2 CH_2 O—	yes	yes	52–54
—CO CH_2 CH_2 CH_2 CH_2 CO O $CH(CH_3)$ CH_2 O—	Syrup thickening to rubber on increasing the molecular weight		

* The figures given are all crystallite melting points determined on the massive polymer.

hyde or urea-formaldehyde condensates, are unsatisfactory for fiber formation, the bulky molecular network being generally insoluble and infusible except at low degrees of condensation and incapable of giving orderly packing. The polymers for fibers must be linear, have good rigidity, and be able to conform to a system of parallel chains, preferably fitting into a well-defined crystal lattice. Projecting side-groups may not only spoil the symmetry of the polymer, but their bulkiness may also spoil the fit between chains. This increases the separation between chains. The net result is a lowering of the melting point, as shown in Table III [3].

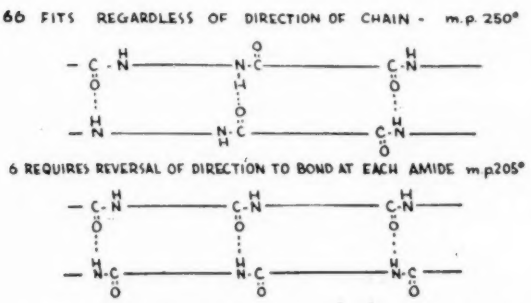


FIG. 3. *The effect of good fit and close packing on the melting point in the case of the 66 nylon and 6 nylon polymers.*

Melting Point

In research directed toward new fibers, the first aim must be to build up thermally stable structures which are crystalline and fiber-forming and have a sufficiently high but not too high melting point. In the case of 66 nylon and 6 nylon (the latter is trademarked "Perlon" by some European producers), there is a good example of the effect of good fit and close packing on melting point (see Figure 3). These polymers are isomers. 66 Nylon melts at 250°C, and 6 nylon at 205°C. The reason for this difference in melting point is the fit between adjacent chains. By sliding one 66 chain along the next, it is possible to bring each amide group into position where it can form a hydrogen bond in two directions. To do this with 6 polymer requires that every other chain be reversed in direction, an extremely improbable arrangement.

This same problem of fitting and packing of the chains is involved in the alternating effect noted in the melting points of even and odd numbers of the nylon polymer series, illustrated in Table IV.

The falling off in melting point from the top to the bottom of the above series may, in a general way, be regarded as the result of diluting high-melting amide groups with increasing amounts of low-melting polymethylene. Melting consists of separating the

TABLE IV

Nylon	Intermediates	M.P.* polymer
4-6	Tetramethylenediamine-adipic acid	278
5-6	Pentamethylenediamine-adipic acid	223
6-6	Hexamethylenediamine-adipic acid	250
7-6	Heptamethylenediamine-adipic acid	235
8-6	Octamethylenediamine-adipic acid	235
9-6	Nonamethylenediamine-adipic acid	205
10-6	Decamethylenediamine-adipic acid	230

* Melting points were determined on a Bloc Macquenne.

molecules, and it naturally can be accomplished more easily if the intermolecular bonding forces are decreased by loose packing and poor fit of the chains.

Irregularity in the chain introduced by copolymerization may also reduce the melting point by spoiling the fit of the chains into a compact lattice. Figure 4 shows how the melting point varies as 66 nylon is copolymerized with increasing portions of 6 nylon. A characteristic minimum is observed in the melting point *versus* composition curve, which in this case is at 40% 66 nylon and 60% 6 nylon. This is also the composition of maximum solubility, indicating a decrease in the compact nature of the crystallites. This composition is soluble in alcohol, whereas 66 and 6 polymers require more active solvents, such as phenol and formic acid.

Interchain Attraction

There should be a high degree of interchain attraction or high intermolecular cohesion due to secondary valence and van der Waals' forces, thus giving a high melting point and the ability to maintain induced orientation. If no such strong forces are present, the molecular chains show a marked tendency to contract to the crumpled form on release of the extending forces. Also, if these cohesive forces are slight, the fibers may remain extended but will contract under the action of heat or solvents.

In crystalline polyhexamethylene adipamide (66 nylon) there are hydrogen bonds acting between the amide groups on different chains, as well as covalent forces existing within each chain. Weak van der Waals' forces also act between the chains and, thus, there is a tightly bound structure. The strength of these bonds and the regularity of their location along the chain, which contributes to close packing and crystallization, are responsible for the high melting point of 66 nylon. They also contribute to the strength of the fiber and its high elastic recovery.

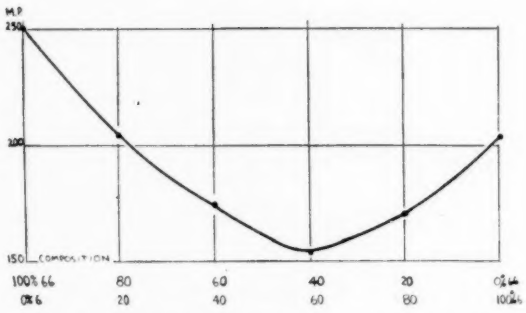


FIG. 4. *Disorder introduced by copolymerization.*

It is not surprising that nylon possesses an outstanding combination of strength, elasticity, toughness, and abrasion-resistance. It is believed that these properties stem directly from the flexibility of the polymer chain, the relatively high polymethylene content of the chain, the strength of the forces operating between the amide groups, and steric factors which are favorable to efficient operation of these forces. Toughness and high abrasion-resistance result from the combination of low elastic modulus, which favors spreading of the load to all parts of the fiber, and high strength, which prevents rupture.

The contribution of interchain forces to the physical characteristics of the polymer is shown by reducing these forces. This can be done by substituting alkyl or alkoxyl groups for some of the amide hydrogens in nylon [3, 7]. The bulky side-groups prevent crystallization of the chains, yet the unsubstituted amide groups remaining serve as links between the chains.

"The melting point falls rapidly with increasing substitution, accompanied by a reduction in modulus. There is a steady transition through the rubber-like state until finally, with complete substitution, the stage is reached where the polymer is a viscous liquid" [3].

Elastic nylons, based on this principle, have been produced experimentally but have not been commercialized.

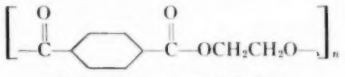
Chain Stiffness

The discovery by Whinfield in 1941 of polyethylene terephthalate as an excellent fiber-former is an outgrowth of the earlier pioneering work of Carothers and his coworkers [6]. Although polyesters had been found to be low melting, Whinfield and his associates felt that molecular symmetry was extremely

TABLE V. MOLECULAR WEIGHT-VISCOSITY RELATIONSHIP

	Molecular weight	Intrinsic viscosity	Melt viscosity (poises)
66 Nylon	18,000	1.3	1500
Polyethylene terephthalate	18,000	0.3	300

important in its relationship to melting point. He examined the isomeric benzene dicarboxylic acids in order to confirm the importance of symmetry. These researches resulted in the synthesis and commercial production of polyethylene terephthalate for polyester fibers trade-marked "Terylene" by Imperial Chemical Industries, Ltd., in England, and trade-marked "Dacron" by DuPont in the United States. This polymer has the convenient advantage of sufficient heat stability to permit its use in the melt spinning process that had been developed with nylon.



Polyethylene terephthalate

The incorporation of the benzene nucleus was thought to have stiffened the chain and probably increased the interchain attraction as well. This has been clarified by Edgar and Hill [2], who emphasized the significance of the *para*-phenylene linkage as an important factor in the determination of polymer and fiber properties. These researchers also examined other polymer structures containing the *p*-phenylene linkage, and showed that its influence is independent of any polar groups that may be present. X-ray examination of polyethylene terephthalate and related substances has revealed no evidence of unusually strong intermolecular forces such as hydrogen bonding. The high melting point induced by the *para*-phenylene linkage was shown to be due to chain rigidity rather than solely to strong interchain reaction.

The effect of stiffening the chain with the *para*-phenylene linkages is first noted in the properties of the melt. At a given molecular weight, the polymer has a lower intrinsic viscosity and a lower melt viscosity than nylon, as shown in Table V.

Apparently, flexibility in the nylon chain leads to entanglement with adjacent chains, which contributes to viscosity. It has also been observed that fiber-forming polyethylene terephthalate must be of substantially higher molecular weight than is required for the aliphatic nylons. Aromatic nylons resemble polyethylene terephthalate in this respect.

The stiffness of the chain in "Terylene" and "Dacron" polyester fibers contributes to their exceptional resilience and resistance to wrinkling. In addition, the interchain forces that also contribute to this high resilience are not relaxed by moisture. Because the fiber absorbs little moisture (1% at saturation), its properties are almost the same in both the wet and dry state. This combination of properties is very important commercially. Thus, garments of polyethylene terephthalate fiber are exceedingly resistant to mussing and will retain their fresh appearance through repeated washings without subsequent ironing.

To summarize, melting point, spatial symmetry, crystallinity, orientability, chain interaction, and chain stiffness are all major contributory factors determining whether the high polymer is a fiber, a rubber, or a plastic. All synthetic polymers can be placed in one of the following overlapping zones:

(*1*) The rubber-like zone, in which the forces between the chains are weak and the chains themselves are flexible. If the chains are of sufficient length, the characteristic rubber-like state is achieved.

(*2*) The amorphous or glass-like zone, in which the chains are less flexible or the intermolecular forces are stronger. In this zone occur many of the plastics of commerce.

(*3*) The crystalline or fiber-forming zone, in which the regularity of the chains permits crystallization to occur along portions of their length. In this zone are polymers with weak interchain forces, as in polyethylene, or with strong hydrogen bonds, as in the case of nylon.

Morphology

Until recently, fiber research has had the objective of finding suitable fiber-forming polymers and developing adequate manufacturing processes for conversion of the polymer to fibers. This task has been of such magnitude that little consideration has been given to morphology as a variable of fiber synthesis. We have recognized the morphological differences in fabrics made from spun staple yarns and continuous filament yarns. Research is now being directed toward varying the morphology of filaments by manipulating the chemical structure of the fiber-forming polymer, the process for conversion to fiber, and, finally, by changes in the fibers as presently mar-

keted. Research on the shape of cross section, contour, surface, and randomizing of filaments is yielding interesting results; and it is expected that the morphological changes will greatly extend the diversification of fiber properties.

The Future

The diversity of characteristics of the new fibers has greatly increased the latitude of the textile technologist from the standpoint of designing fabrics that will possess functionality and aesthetic properties for specific uses. The wide versatility of fabrics resulting from these new fibers is certain to have a stimulating influence on the entire textile industry. Textile research has revealed that fabrics possessing greater versatility of function and design may be obtained by blending the new synthetic fibers with rayon, acetate, wool, and cotton, and it has been demonstrated that the chemical fibers and the natural fibers are complementary to each other [8].

While on the one hand there will be more signposts to guide scientists in the search for new fibers, it will become increasingly difficult to find new fibers of outstanding merit. The future of today's fibers will be greatly dependent upon the skill and ingenuity of the textile industry in designing fabrics to utilize their distinctive properties in the most skillful manner. Intensive research on new dyes, new methods of dyeing, elimination of static electricity and pilling, and, finally, the influence of different kinds of clothing on physiological reactions must be carried out to support this new industry, in which there is so much confidence and enthusiasm at the present time.

Acknowledgment

The writer wishes to acknowledge the assistance of Dr. W. W. Heckert in the preparation of this brief review.

Literature Cited

1. Carothers, W. H., "Collected Papers of W. H. Carothers on Polymerization" (edited by H. Mark and G. S. Whitby), New York, Interscience, 1940.
2. Edgar, O. B., and Hill, R., *J. Polymer Sci.* **8**, 1–22 (1952).
3. Hill, R., *J. Soc. Dyers Colourists* **68**, 158–68 (1952).
4. Smith, H. D., *Proc. Am. Soc. Testing Materials* **44**, 1–62 (1944).
5. Smith, L. H., "German Synthetic Fiber Developments," New York, Textile Research Institute, 1946, pp. 41, 48, 443–51.
6. Whinfield, J. R., *Endeavour* **11**, No. 41, 29 (1952).
7. Wittbecker, E. L., Houtz, R. C., and Watkins, W. W., *Ind. Eng. Chem.* **40**, 875 (1948).
8. Quig, J. B., and Dennison, R. W., *Ind. Eng. Chem.* **44**, 2176–83 (1952).

The Development of Terylene

J. R. Whinfield*

THIS paper gives a more or less factual account of the development in Britain of the synthetic fiber known as "Terylene." This is a polyester fiber derived from polyethylene terephthalate, a condensation polymer resulting from the polyesterification of ethylene glycol with terephthalic acid. It was discovered in a textile research laboratory in Lancashire in 1941. A similar fiber is now manufactured in the United States under the name "Dacron."

The word "development" is in danger of becoming overworked these days. Whatever its dictionary definitions, it has come to mean a curious blend of invention and business activity which somehow manages to convert the mere knowledge of things into practical use. The present paper is concerned not only with development in the above sense, but also to some extent with the acquisition of the knowledge to which this process is being applied.

On this basis it will be convenient to divide the discussion into three parts which roughly cover three phases. First it is related how Terylene came to be discovered; this is the phase of the laboratory. The second part discusses some of the considerations which led to the exploitation of this discovery on a commercial scale; this is the phase of the pilot plants and of the evaluation of their products. Finally, a brief indication is given of what is involved in this exploitation; this is the phase of large-scale manufacture.

The Discovery of Terylene

The discovery of Terylene resulted from the working out of a very simple idea, and the idea itself was largely derived from a study of the work of the late Dr. W. H. Carothers.

Early in 1930 Carothers had established the fact that the ordinary condensation reactions of organic chemistry could be used to synthesize linear polymers of high molecular weight. A typical example of this procedure is provided by the reaction between adipic acid and ethylene glycol, which, on heating under the appropriate conditions, gives a polyester containing the structural unit

$$—OC—(CH_2)_4—CO—O(CH_2)_2—O—.$$

When the molecular weight of this polyester is low, it is a brittle microcrystalline wax. However, when the molecular weight exceeds about 10,000, it becomes hard and horny and the melt is very viscous. Carothers made the remarkable observation that on touching the melt with a rod and drawing the rod away a filament is obtained, which when gently pulled extends to about four times its original length and is then very strong and pliable. To this latter process Carothers gave the name "cold-drawing," and he showed that the effect of cold-drawing is to orientate the molecular chains and crystallites in a direction parallel to the long axis of the resulting fiber.

The production of these microcrystalline and fiber-forming condensation polymers was found to be a general phenomenon, and not confined to polyesters, always provided that the molecular chains possess a certain symmetry. If this symmetry was disturbed either by the presence of bulky side-groups or by starting with materials which themselves were unsymmetrical, the resulting polymers were noncrystalline and would not yield fibers. Thus, the polyester derived from *o*-phthalic acid and ethylene glycol proved to be an amorphous glasslike substance, and this must be ascribed to the fact that the molecule of *o*-phthalic acid is itself very unsymmetrical, so that the derived polyester chains either cannot be straightened out or, if they can, remain unsymmetrical.

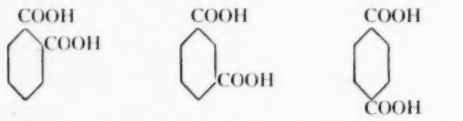
However, none of the microcrystalline fiber-forming polyesters obtained by Carothers from aliphatic acids and alcohols were of any practical value for the simple reason that they all possessed extremely low melting points (below 107°C). He therefore turned his attention to the analagous polyamides, and he found these to have much higher melting points (above 200°C). It was this fact that ultimately led to the production of the first synthetic fiber—an aliphatic polyamide now known as "nylon."

Shortly afterwards, in 1940, J. T. Dickson and the author, while working in the laboratories of the Calico Printers' Association Ltd., Lancashire, seized

* Terylene Council, Imperial Chemical Industries Limited, Welwyn, Hertfordshire, England.

upon the question of the relation between crystallinity and molecular symmetry of condensation polymers as one which merited further study. We were soon struck by the possibilities inherent in nuclear isomerism.

Consider, for example, the very simple case of the three benzene dicarboxylic acids. A glance at the structural formulas of these acids is sufficient to show that in the matter of symmetry terephthalic acid stands apart from the other two. It has a highly



o-phthalic acid isophthalic acid terephthalic acid

symmetrical structure, whereas both *ortho*-phthalic and isophthalic acids are very unsymmetrical. It was already known that the glycol polyesters of *ortho*-phthalic acid were amorphous; it was a reasonable expectation that those of terephthalic acid would be crystalline, and hence fiber-forming.

There is a further point to notice about terephthalic acid in comparison with the aliphatic dibasic acids. The skeleton of adipic acid, for example, consists of six carbon atoms which have a very considerable freedom of movement through rotation about the C—C bonds. The molecule of this acid can therefore assume an almost endless variety of configurations. But in the case of terephthalic acid the situation is very different; the molecule has six carbon atoms held in one plane—an extremely rigid structure and one which might be described as a very sound piece of molecular engineering. If we consider the glycol polyesters of adipic acid and of terephthalic acid, we must expect them to show some quite striking differences in character because of the flexibility of the acid segment in the one and the rigidity of this segment in the other.

Research is directed by knowledge, but it is enlivened by an element of unexpectedness. Knowledge suggested that polyethylene terephthalate would prove to be a fiber-forming polymer. Knowledge also suggested that in some other respect it would differ from the aliphatic polyesters, but provided no real clue as to what the nature of this difference would be. This could be settled only by actual experiment.

The result of the experiment was to confirm our expectations in regard to the fiber-forming propensities of the polyester and to reveal at once its special character. This proved to be high melting point. Polyethylene terephthalate has a melting point near 264°C; that of ethylene adipate is 57°C.

Terephthalic acid is a somewhat intractable substance. It is very sparingly soluble and sublimes without melting at about 300°C. This occasioned some initial experimental difficulties, but ways of overcoming these were soon found. Purification of the acid was effected via the dimethyl ester, a crystalline solid. Later this ester was itself used in the polymerization reaction in place of the free acid. Several peculiarities of the polyester were noted. For example, rapid cooling of the melt yielded the polyester in an amorphous form—a glass-clear solid—which on heating reverted to the microcrystalline state. The fibers themselves were found to resist hydrolysis—another rather unexpected property.

It is perhaps unnecessary to say that the work did not come to an end with the discovery of polyethylene terephthalate. It was quickly extended to other glycol esters of terephthalic acid and to other aromatic dibasic acids of symmetrical constitution. The influence of such acids on melting point was found to be quite general, and has since been studied in great detail by many workers. But—and this is an interesting fact—the simplest case of all was provided by polyethylene terephthalate, and it was this polyester, produced substantially in the way that it was prepared the first time, that later came to be developed on a commercial scale. None of the many possible alternatives could compete with it.

Pilot Plants and the Evaluation of Their Products

This was the situation as it existed by the middle of 1941: Polyethylene terephthalate had been prepared on the 500-g. scale by direct esterification using the free acid and by ester interchange starting with dimethyl terephthalate. If the polymer was to be free from color, the use of very pure reactants was clearly essential. By the simplest of techniques, such as were used by Carothers in his early work, crude fibers had been drawn from the viscous molten polymer, and these could be oriented by subsequent cold-drawing. These fibers seemed to be very strong and extensible, although no actual measurements of these properties had been made. The three physical states in which the polymer could exist—namely, amorphous; crystalline with random crystallite orientation; and crystalline with high orientation in a single direction—had been clearly delineated. The

fibers were shown to have a low moisture regain, and to undergo no appreciable swelling in water, so that dyeing was evidently going to present some problems. But, apart from all the above observations, these "Terylene" fibers—as we had christened them—displayed two properties, both of which were of quite outstanding interest, and both of which were also of a somewhat unexpected character.

In the first place, they were very resistant to hydrolysis, whether catalyzed by hydrogen or hydroxyl ions. Had this not been so—and it might well not have been, considering that the chains were held together by recurrent ester linkages—the fibers would have been completely valueless. In the second place, they had a high melting point—in the region of 260°C—which was well within the range of the aliphatic polyamides as typified by nylon. This was the property more than any other which distinguished Terylene from all known polyester fibers. It was, indeed this powerful combination of chemical and physical stability that carried Terylene forward from the laboratory to the next phase.

It is perhaps of historical interest to record that publication of the relevant patent specifications was delayed on account of the war, and no serious consideration could be given to the further development of Terylene at the time of its discovery. It was not until peace had been restored that the matter could be taken up once more.

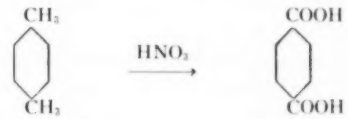
It is very important to observe that terephthalic acid, the residues of which represent over 80% of the Terylene molecule, was anything but a common chemical substance in 1941; on the contrary, it was little more than a laboratory curiosity. If, therefore, there was to be any thought of manufacturing Terylene on a large scale, a commercially feasible synthesis of terephthalic acid would have to be worked out. This was scarcely a task that any section of the textile industry was equipped to undertake. For this reason, if for no other, commercial exploitation had necessarily to pass from the textile to the chemical industry. In pursuance of this, in 1947 the Calico Printers' Association Limited, in whose laboratories the original work had been carried out, entered into a suitable arangement with Imperial Chemical Industries Limited, and from that time on all further development of Terylene in Britain became the responsibility of the latter company.

At the outset of this new phase answers had to be sought to a large number of questions. Among these, four were of paramount importance. They were as follows: (*1*) Could a commercial synthesis of terephthalic acid be established? (*2*) Could the production of the polymer on a large scale be satisfactorily controlled? (*3*) Could a workable process be found for the conversion of polymer into yarn or fiber? (*4*) Were the properties of the resulting yarns and fibers such that these would find a market in the textile industry at the price at which they could be produced and sold?

The answers to these four questions, which have since emerged, are discussed below.

(*1*) *Synthesis of terephthalic acid.*—The fact that this acid had never before been produced on a large scale merely meant that no important use for it had been found and that no demand for it existed. Even from the start there was good reason to think that this acid would prove to be commercially accessible.

The most promising route to date, and the one which is now being used, is based on *para*-xylene, which on oxidation with nitric acid yields terephthalic acid:



para-xylene terephthalic acid

There are two sources of *para*-xylene—namely, coal tar and petroleum oils. Of these, the latter is the more attractive. Recent advances in petroleum technology, and more especially the process of "platforming," have made available concentrates rich in C_8 aromatics from which *para*-xylene can be crystallized out by refrigeration, and the yield of this substance further increased by subsequent isomerization. Although an enormous amount of detailed work was necessary at all stages, it soon became apparent that sufficient *para*-xylene would be available for the manufacture of many millions of pounds of Terylene, and that its conversion to terephthalic acid would offer no serious obstacle.

The second and minor component of Terylene—ethylene glycol—was already in commercial production, and no difficulty was foreseen in stepping up this production to meet the new demand created by Terylene.

Thus, in the vital matter of the supply of raw materials, a sound position was eventually established, but, with the long-term future in mind, alternative routes to these raw materials remain under constant review.

(2) *The production of polymer.*—The condensation polymerization reaction leading to polyethylene terephthalate presents some peculiarities. The translation of this reaction from the 500-g. scale to one of several hundreds of pounds was, in itself, something of an achievement. It was found preferable to start with dimethyl terephthalate rather than with the free acid, not only because the dimethyl ester could be obtained more readily in a high state of purity, but for other reasons as well. In a process of this kind side reactions must be avoided at all costs, since these could, and generally do, have many undesirable consequences. The only obvious side reaction which might occur in the preparation of Terylene is that of etherification through self-condensation of glycol molecules, resulting in polyethylene glycols of the type

$$HO(CH_2)_2—O—(CH_2)_2—O—(CH_2)_2—O—$$

which, becoming incorporated in the polymer chain, tend to destroy crystallinity and lower the melting point. Fortunately, it did not prove difficult to avoid this reaction. The problems remaining were to obtain the starting materials in a state of high purity, to prevent any decomposition during the course of polymerization, and to control the average molecular weight of the resulting polymer within comparatively fine limits. These are not in any way exceptional problems, and it is perhaps only necessary to say that all have yielded to intensive study and hard work.

(3) *Conversion of polymer to yarn and fiber.*—Having reached assurance on the question of the polymer, there was then the question of converting this to yarn or fiber. Since Terylene is a very insoluble substance, it was quite clear from the start that this conversion would have to be achieved by spinning from the melt. Fortunately, the melt-spinning process had already been established for nylon, and it seemed very probable that this could be modified and adapted to accommodate Terylene, more especially since one would be operating within a similar temperature range. This hope proved well founded, although here again a great deal of detailed work was necessary. From the point of view of general interest it is sufficient to say that the conversion of both nylon and Terylene polymer into yarn and fiber is achieved by similar processes, except that in the latter case heat is applied at the drawing stage. This application of heat is not merely a matter of expediency, but is closely related to the fact that the transition temperature of Terylene (approximately 80°C) is very much higher than that of nylon (approximately 40°C). The transition temperature marks the point at which some freedom of molecular movement first becomes possible. In the case of nylon the heat generated in drawing is sufficient to bring the fiber above the transition point, but in the case of Terylene this is not so, and an external source of heat becomes necessary.

(4) *The properties and uses of Terylene yarn and fiber.*—The pilot plants, which had been erected, had to produce substantial quantities of yarn and fiber. Economic studies were necessary in order to determine, if only to a first approximation, the prices at which the yarn or fiber could be manufactured and sold in bulk.

As soon as material began to come forward from these pilot plants, it was possible to make a much more detailed examination of the properties of the yarn and fiber and later to supply limited quantities of these to the textile industry to be used for those purposes for which they seemed to be best fitted.

All this proved to be a highly complex and lengthy undertaking, but in no other way was it possible to arrive at a rational decision as to whether or not to incur the heavy capital investment required for the building of large-scale plants for the manufacture of this fiber on a commercial scale.

Without suggesting that Terylene is not possessed of some properties which it would be better without, or that it does not lack others which would be to its advantage, it would be fair say that throughout this phase of the work it turned out quite as well as, and in some respects better than, might have been expected. In other words, the early promise which it showed in the laboratory was fully maintained throughout the far more searching examination which it had to undergo.

Some of the most outstanding properties of the yarns and fibers which then became established are discussed below.

According to the spinning and drawing procedure adapted, tenacity could be varied between the approximate limits of 3 and 7 grams per denier. Extension at break ranged from below 10% to above 30%, and was inversely related to tenacity. Recovery from strains of up to about 5% was complete. Provided a sufficiently high draw ratio was employed, the initial modulus of the fibers was also high—about 170 grams per denier—and in this respect they were rather sharply differentiated from nylon, the initial modulus

of which is very much lower. The fibers proved to be very tough, using this word in its everyday context, and resistant to abrasion. Their general chemical inertness was fully confirmed, and in addition they were found to display a very good measure of resistance to photochemical degradation. As had been foreseen, the dyeing of these fibers presented a number of problems, and has since been the subject of much investigation. Only two classes of dyes—dispersed colors and azoic colors—were found to be of any practical value, but these provided a wide range of shades, and several interesting techniques for their application have since been worked out.

The prediction of the properties of textile structures from a knowledge of the properties of the fibers of which they are composed is still in its infancy, and is in any case never likely to become an exact science. It is greatly complicated by a multiplicity of form factors. A very obvious and elementary illustration of such factors is furnished by filament yarn and staple fiber. Terylene, in common with most synthetic fibers, can be produced in both of these forms. It was in connection with fabrics made from yarns composed of Terylene staple fiber that one of its most outstanding qualities emerged. This is the quality of resilience, which was found to be extremely high, and roughly comparable with that of wool. This quality of resilience in Terylene was an unexpected one; at any rate, it could scarcely have been predicted from a knowledge of its molecular architecture. Even today no entirely satisfactory explanation for it has been found. There is, however, no doubt about its existence, and since resilience is a very highly prized property of textile materials, the potential value and importance of Terylene is immensely enhanced by its possession of this property.

Towards the end of 1950 a very wide exploration of the field open to Terylene as a textile yarn and fiber enabled a decision to be reached on the question of large-scale commercial production. The effort which had been made up to that time had involved the expenditure of a sum in excess of the equivalent of 6 million dollars. The decision reached was to build plants for the annual output of some 11 million pounds of yarn and fiber, at a cost exceeding the equivalent of 30 million dollars. These plants are now in the course of construction, and will be in operation towards the end of 1954.

It is not without interest to look at the history of this development in terms of money. While it is difficult to estimate the actual cost of the discovery itself, it may be noted that this was made in a small textile laboratory which certainly required less than the equivalent of $50,000 a year to maintain. To take the discovery from the laboratory through the phase of pilot plants and the appraisal of their products involved expenditure amounting to more than a hundred times this sum, while the capital investment required for commercial production represented a multiplication of the estimated discovery cost by a factor of at least 600. This is a very high rate of progression, and illustrates clearly the fact that while ideas and the acquisition of new knowledge may be cheap enough, the conversion of these ideas and this knowledge to practical use is rather a costly undertaking.

Commercial Exploitation

Commercial exploitation is now going forward in Britain with the erection of plants to produce annually 11 million pounds of Terylene in filament and staple form. These plants will occupy a site at Wilton, Yorkshire, where all stages of manufacture, starting with mixed xylenes and ending with the finished yarn and fiber, will be carried through, and where a supply of the minor component, ethylene glycol, is near at hand.

It is always a difficult question to decide the initial scale of an enterprise of this kind. There is, of course, a minimum scale dictated by the fact that the cost of manufacture at first falls very rapidly with increase in output. However, beyond a certain point the fall becomes less marked, and eventually reaches a stage where further increase in scale has little or no effect on manufacturing cost. The projected output of the plants at Wilton lies somewhat beyond this stage.

One has then to consider the potential market, and it is here that a really reliable crystal would be of the utmost value. The best substitute for this unobtainable piece of equipment is faith tempered by calculation. This combination leads us to the view that the market open to Terylene must eventually greatly exceed the capacity of the first series of plants, so that serious consideration is now being given to their extension on a very considerable scale. But this lies in the future.

This history of the development of Terylene thus illustrates the successive steps by which an idea about synthetic fibers became translated into a commercial reality.

The Synthesis and Applicability of Block and Graft Copolymers

H. F. Mark*

Introduction

Binary copolymers with equal or almost equal molar proportions of the two constituents have been found to possess either a regular (*I*) or a random (*II*) alternation of the two monomers:

—A BA BA BA BA BA BA BA BA BA BA B— (*I*)

—A BBAAA B BA BAA B B BA B BAA BAA B— (*II*)

The first sequence is favored if the two interacting monomers have approximately the same *Q*-value but *e*-values of opposite sign,† as, for instance, in the copolymerization of styrene and acrylonitrile or stilbene and maleic anhydride. Sequence *II* is preferred if the *Q*-values and *e*-values of the two copolymerizing components are similar in magnitude and sign, such as in the system methylacrylate-ethylacrylate or styrene-*para*-chlorostyrene. It has been proposed to call *I* an "ordered" or "regular" equimolar copolymer, and *II* a "random" or "disordered" copolymer of A and B. If molecules of these two types have equal molecular weights (or average molecular weights), they can be called "isomers" because they have the same (average) molecular weight and the same chemical composition and differ only in respect to the details of the arrangement of the two monomeric units in the chain. Essential in both cases is that the alternations between A and B are frequent and, as a consequence, occur over the range of a few Ångström units. In *I* the distance between monomers of the same kind is strictly regular, and amounts in polyvinyl derivatives to about 3 Ångström units; in *II* this distance fluctuates between zero and several Ångström units, but it has been demonstrated [1, 2] that the probability of finding a longer stretch of either A or B decreases rapidly with the length of the stretch.

The blending of the two constituents A and B is very intimate, and "crossing over" from A to B or from B to A takes place on a micromolecular scale. In consequence, certain properties of such normal copolymers have been found to be essentially an approximate average of the corresponding properties of the two components. If A, for example, is an oil-compatible monomer, such as styrene or isobutene, and B is a water-compatible monomer, such as vinyl alcohol or vinylpyrrolidone, poly-A is soluble in benzene and poly-B in water, whereas copolymers of A and B of type *I* or *II* are soluble in mixtures of polar and nonpolar solvents, such as acetone and benzene, or in solvents of intermediate polarity, such as dioxane or carbon tetrachloride.

The question now arises whether there exist other isomers of copoly-AB—namely, macromolecules which have the same molecular weight and equimolar composition, but differ in the details of the arrangement of A and B along the length of the chain. Evidently, if one could, in some manner, produce long alternating stretches of A and B such as

—A.....A—B.....B—A.....A—B.....B—
50A 50B 50A 50B (*III*)

one could call *III* another macromolecular isomer of copoly-AB, provided that its degree of polymerization (D.P.) or average degree of polymerization is the same as that of *I* or *II*. In fact, *III* does not represent *one* new isomer, but a whole spectrum of them, because, even if we keep the molar ratio and the total D.P. constant, we can still vary the length of the uninterrupted sequences of A and B. If we decrease the size of these "blocks" to one monomer unit, the block copolymer* *III* becomes a normal ordered copolymer of A and B; if we increase the length of the stretches to ½ D.P., we arrive at a macromolecule which is half poly-A and half poly-B. It is evident that block copolymers of a few very large blocks will eventually display similar properties as a mechanical

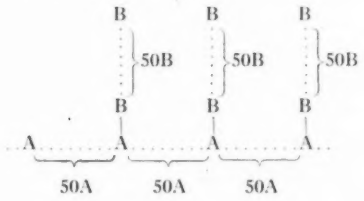
* Director, Institute of Polymer Research, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

† For the fundamentals of copolymerization compare [1] and [2].

* This name was proposed by Dr. G. F. Tuckett at the occasion of a lecture at the Gordon Research Conference on Textiles in 1952.

mixture of poly-A and poly-B; such mixtures are called "polyblends." We shall, in this brief review, deal essentially with block copolymers having alternating stretches of A and B in the order of magnitude of about 50.

If we admit branching of the polymers under consideration, we can add a fourth type of copolymer of A and B which also can be considered to be isomeric to *I*, *II*, and *III*—namely, a macromolecule which consists of a "backbone" or "trunk" of poly-A with a (relatively) small number of "branches" of poly-B, provided that the molar ratio of A to B is 1:1 and that the total D.P. of the molecules is equal or similar to that of *I*, *II*, or *III*.



(*IV*)

Macromolecules of this type have been called "graft" copolymers; in terms of isomerism they represent not a single isomer, but again a whole spectrum of them, because one can vary the average distance and average length of the branches without changing the 1:1 molar ratio and the total D.P.

Block and graft copolymers represent a much coarser mixture between A and B than do ordered and random normal copolymers; the individual sequences of A and B already display to a certain degree some of the characteristics of poly-A and poly-B, and, as a consequence, certain properties of *III* and *IV* will be a superposition of the properties of poly-A and poly-B rather than an average. This has, in fact, been found to be true. If A is a typically oil-compatible and B a typically water-soluble monomer, equimolar block and graft copolymers of the two components are surface-active materials which exhibit interesting behavior as emulsifiers, detergents, antistatic agents and protective colloids. They resemble normal surface-active molecules of ordinary size which also consist of hydrophilic and hydrophobic domains tied together chemically in one molecule. It is well known that low-molecular-weight detergents have a tendency to form micelles, which are responsible for their solubilizing and emulsifying capacity. These micelles are relatively transient systems, which change in size, shape, and degree of consolidation with such variables as concentration, temperature, and dielectric character of the solvent.

In the case of amphoteric block and graft copolymers, the molecules themselves are the micelles. If we want large micelles, we will synthesize large copolymer molecules; if we want small micelles, we must synthesize a lower-D.P. copolymer. But once this choice is made, the size of the solubilizing and emulsifying units is practically independent of concentration and temperature. This has the consequence that graft and block copolymers permit the formation of remarkably stable emulsions and suspensions.

If we consider, for the purpose of illustration, a graft copolymer of styrene and vinyl alcohol consisting of a trunk chain of 500 styrenes and of 20 branches with 25 vinyl alcohols each, this material is soluble in water and also in toluene. In water, the polystyrene segments are evidently insoluble and aggregate to a relatively dense particle of polystyrene, which would associate with other particles of the same kind and would eventually precipitate out as polystyrene. This, however, does not occur in the case of a graft or block copolymer because the insoluble polystyrene stretches are chemically linked (and, hence, permanently) to the easily water-soluble polyvinyl alcohol branches. These segments are strongly solvated in water and keep the insoluble part of the macromolecule in stable suspension. If benzene is added to such a system, it is accommodated in the oil-compatible polystyrene domains of the dispersed copolymer molecules, and we observe, as in the case of a low-molecular-weight detergent, the phenomenon of solubilization of benzene in water.

If the same copolymer is placed in benzene, the reverse happens—namely, the segments of polyvinyl alcohol collapse on each other and form a densely packed insoluble core which would eventually precipitate as a solid (slightly swollen) phase if it were not for the chemically attached polystyrene stretches, which are easily oil-soluble and keep the macromolecule in solution. In this situation, the graft copolymer displays a marked capacity to solubilize water or other polar liquids in the hydrocarbon phase.

Using a somewhat oversimplifying language, one might say that in each of the two solvents—water and benzene—only "half" of the graft copolymer is "dissolved," whereas the other "half" is "precipitated." However, in a liquid which is a solvent for polyvinyl alcohol and polystyrene (such as a mixture of toluene, dimethylformamide, and water) no part of the

macromolecule is "collapsed"; all segments (the trunk chain and the branches) are solvated and the whole graft copolymer is "dissolved." Intrinsic viscosity and light-scattering dissymmetry measurements support this concept.

The nondissolved fractions of a graft or block copolymer have, according to the principle of Gibbs, a certain tendency to arrange themselves and, hence, the whole macromolecule at the surface of the phase with which they are incompatible, and have a still increased tendency to accommodate themselves at an interface so that one half of the molecule is soluble in one phase and the other half in the other phase. The graft copolymers of styrene and vinyl alcohol are concentrated at a benzene-water interface. This surface activity also manifests itself in polymer solutions and even gels, and leads to a number of potential applications of such materials in the surface treatment of fibers and films in order to produce adhesion or water-repellency and to reduce mechanical friction or static charges. After this brief enumeration of a few typical properties of graft and block copolymers, we shall now pass to an equally brief description of the principles of their synthesis.

Synthesis of Graft Copolymers

The first copolymers having longer stretches of the monomeric constituents were of the grafted type, and it may therefore be appropriate to start with a description of the various ways to prepare them.

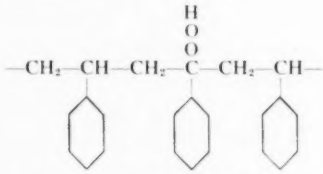
One method, although not a very good one, uses the principle of chain transfer [3]; it consists simply of taking a polymer (poly-A), such as polystyrene or polyisobutene, dissolving it in a suitable solvent, such as benzene, and polymerizing in the presence of the macromolecules of this polymer another monomer (B), such as vinylacetate, with the aid of a radical-forming initiator. Under these conditions, the free radicals formed by the decomposition of the initiator not only react with the monomer B to produce poly-B, but also abstract certain atoms, such as H, Cl, and Br, from the macromolecules of poly-A and hereby create unpaired electrons somewhere along the length of the chains of the first polymer. These free radicals initiate polymerization of the second monomer and, as a consequence, grow branches of B out of the trunk chain of poly-A.

This method has been applied by several authors [4]; its success depends on the frequency of the chain-transfer step as compared with the propagation step of B-polymerization. In general, this ratio is not favorable for the transfer reaction and, hence, the product obtained is very heterogeneous. Its constituents range from pure poly-B, which forms in competition to the grafting process, to pure poly-A, formed by macromolecules of the first polymer which were not attacked by free-radical type fragments of the initiator and did not, therefore, partake in the branching reaction. Between these extremes extends a virtually continuous spectrum of macromolecules having all intermediate compositions.

It is possible that for certain practical applications the nonuniformity of the graft copolymer is no serious obstacle; in fact, there might be cases where it is an advantage.* But for a quantitative study of the kinetics of grafting and of the structural details of the branched copolymer molecules, a clean fractionation and purification of the reaction products appear to be indispensable. Graft copolymers prepared by the chain-transfer method have not responded favorably to any process of separation, and attention is therefore shifting more and more to other principles for their synthesis.

One of them is to distribute in a suitable manner along the length of a given polymer chain widely spaced reactive groups which can serve to initiate a second polymerization reaction. The essential factor here is that the initiation of B-polymerization occurs only at the surface of poly-A and nowhere else in the system. This eliminates the formation of poly-B as an independent and undesirable by-product of the reaction. A few examples may illustrate the practical application of this principle.†

(*a*) Polystyrene in solution is capable of taking up oxygen in a similar manner as cumene, and forms hydroperoxyl groups of the formula



(V)

By carrying the oxidation to small degrees (1–2 mol percent of OOH on the monomer) it is possible to

* Styrenated drying oils and alkyds are systems in which a certain degree of graft copolymerization of monomer B (styrene) with polymer A (alkyd) has taken place.

† Compare R. B. Mesrobian, lecture given at the American Chemical Society meeting in Atlantic City, N. J., Sept. 1952, and results obtained since at the Polytechnic Institute of Brooklyn.

distribute the hydroperoxyl groups in an essentially random fashion with relatively large intervals (50–100 monomeric units). After this modification of the primary polymer (poly-A) one adds the second monomer (monomer B) to the solution together with a redox activator, such as ferrous gluconate. The ferrous ions, Fe^{++}, react with the hydroperoxyl groups according to

$$ROOH + Fe^{++} \rightarrow RO\cdot + OH^- + Fe^{+++} \qquad (1)$$

and produce free radicals, which are all attached to the chains of poly-A. As a consequence, the polymerization of B is restricted entirely to the growth of B-branches from poly-A trunk chains. No competitive poly-B is formed.

(*b*) A copolymer of styrene and vinylacetate is prepared in methylethyl ketone as solvent containing only a small amount (1–2 mol percent) of vinylacetate. Because of the specific relative reactivity ratios of styrene and vinylacetate, the monomeric units of the acetate are isolated and spaced at large distances (50–100 monostyrenes) along the length of the chains. Then the acetate is hydrolyzed, producing widely spaced hydroxyl groups, which can serve to initiate a second polymerization reaction. Upon addition of ethylene oxide, glycidolacetate, butadiene diepoxide, or an *alpha*-amino acid-carboxy anhydride, branches of the second monomer grow out exclusively of the original backbone chain and no competitive poly-B is formed.

Widely spaced hydroxyl groups can also be produced by reducing the hydroperoxyl groups, as mentioned under (*a*), or by reducing widely spaced carboxyl groups with the aid of lithium-aluminum hydride.

It can easily be seen that the principle of distributing widely spaced reactive groups along the length of a polymer chain and using them to initiate a second polymerization reaction can be applied in many other ways. Copolymerization with *para*-aminostyrene, fumarylchloride, or vinylbromide leads to the introduction of such groups at desired distances, permitting the initiation of a polyamide-type chain formation for the production of branches. In general, it seems that groups such as hydroperoxyl, hydroxyl, amino, carboxyl, etc., can be used in a satisfactory manner to grow suitable branches out of a trunk chain.

Several graft copolymers have ben prepared according to methods (*a*) and (*b*) by grafting vinyl alcohol and ethylene oxide on polystyrene; they exhibited typical surface-active behavior, as indicated in the first paragraph of this paper.

Synthesis of Block Copolymers

The methods applied in the synthesis of graft copolymers make it readily understandable how to proceed in order to obtain block copolymers. Apparently it will again be necessary to carry out the synthesis in more than one step, and to prepare first the individual blocks in such a manner that they have reactive groups at both ends. After the blocks have been prepared separately, they are joined together by a suitable bifunctional linking agent. This general principle can be put to work in many different ways, a few of which already have been actually used for the preparation and investigation of block copolymers.

(*a*) If propylene oxide is polymerized with propylene glycol as initiator, one obtains macromolecules with hydroxyl groups at both ends. Chemists of the Wyandotte Chemicals Corp.* have prepared polypropyleneoxides of this type with D.P.'s between 20 and 80, and have then continued the reaction at both ends with ethylene oxide. As a result they obtained macromolecules of the formula

$$HO\cdot(C_2H_4O)_a\cdot(C_3H_6O)_b\cdot(C_2H_4O)_cH, \qquad (VI)$$

where *a*, *b*, and *c* are figures between 20 and 80 which can be varied by the conditions prevailing during the synthesis of the material. These compounds are on the market as Pluronics, and exhibit many valuable and novel characteristics of nonionic detergents; they are block copolymers with a center block of polypropylene oxide and two end blocks of polyethylene oxide.

It appears that similar linear macromolecules consisting of three blocks can be obtained by starting with a bifunctional initiator the polymerization of a given *alpha*-amino acid-carboxy anhydride until a center block of a certain D.P. is formed, and then continuing either with an epoxide or with another Leuchs anhydride to add the two end blocks. It will be interesting to see whether it is possible to add more blocks by returning to the material of the center block or by passing on to a third component. Obviously, it is to be expected that, with increasing molecular weight of the chain and with decreasing solubility,

* Compare the technical information sheets and booklets of the Wyandotte Chemicals Corp., Wyandotte, Mich. (Form 437-9-52).

the rate of the addition of more blocks will decrease sharply and limit this technique to a certain practically attainable number and size of the individual blocks.

(*b*) Evans [5] and his collaborators have shown that if one polymerizes styrene at low temperatures with H_2O_2 and $FeSO_4$ as the initiating system, initiation of the chains is due to hydroxyl radical and termination occurs by recombination. As a consequence, the resulting linear polystyrene molecules have a hydroxyl group at each end. By choosing the appropriate concentrations of monomer, catalyst, and activator it is possible to arrive at the desired relatively low D.P. (20–80) of the polystyrene blocks. In the same manner, polymethylacrylate blocks of similar D.P. with hydroxyl groups at both ends can be prepared. These blocks can then be linked together with a diisocyanate to form linear block copolymers consisting of many blocks and, hence, having molecular weights in the truly high-polymer range [6].

Again it can be seen that other reactive groups at the end of the individual blocks, such as NH_2, COCl, or MgBr, might be used to link the blocks together to a long linear chain.

At present many attempts of this type are under way in various laboratories, and we can look forward with considerable interest to the results in the near future.

Literature Cited

1. Mays, F. R., and Walling, C., *Chem. Revs.* **46**, 191 (1950).
2. Alfrey, T., Bohrer, J. J., and Mark, H., "Copolymerization," New York, Interscience Publishers, Inc., 1952.
3. Flory, P. J., *J. Am. Chem. Soc.* **59**, 241 (1937).
4. Compare Houtz, R. C., and Adkins, H., *J. Am. Chem. Soc.* **55**, 1609 (1933); Carlin, R. B., and Shakespeare, N. E., *J. Am. Chem. Soc.* **68**, 876 (1946); Alfrey, T., and Bandel, D., *J. Polymer Sci.* (in press); Smets, G., and Claessen, M., *J. Polymer Sci.* **8**, 289 (1952); Roland, J. R., and Richards, L. M., *J. Polymer Sci.* **9**, 61 (1952).
5. Baxendale, J. H., Evans, M. G., and Parks, G. S., *Trans. Faraday Soc.* **42**, 155 (1946).
6. Compare Bayer, O., Müeller, E., Peterson, S., Piepenbrink, H. F., and Windemuth, E., *Angew. Chem.* **59**, 263 (1948); **62**, 57 (1950).

Current Problems and Future Trends in Synthetic Fibers

John H. Dillon *

THE IMPACT of modern chemistry upon the three essentials of life—food, shelter, and clothing—has thus far been rather puny. We are still eating steaks, those of us who can afford them, which are produced and prepared by the same methods employed by our ancestors hundreds of years ago. Today, of course, we often buy them frozen—a convenience based on chemical and physical principles—but they are still the same old proteins after we thaw them out. We still build houses of wood, brick, stone, or cement block. Only the last may be considered a remote product of chemistry, and modern insulating materials constitute the only major contribution of chemical science to the construction of a modern dwelling. In the field of clothing, 69% of our 1950 textile consumption was still cotton, 9% was wool, and 0.1% was silk. But 20% of our textile materials were made of viscose and acetate rayon, and we actually consumed true synthetic fibers to the extent of 2%. This latter figure is somewhat larger today, and will continue to increase. Hence, if we consider only the replacement of natural materials by the synthetics as basic elements of construction, the textile industry is the most advanced of the "big three" dedicated to supplying the basic wants. It must be acknowledged, of course, that enormous chemical progress has been made in the fields of transportation, communication, amusement, medicine, and warfare; perhaps these should now be included among the elementary needs of mankind.

* Director, Textile Research Institute, Princeton, N. J.

The Advanced Textile Industry

It is becoming increasingly tiresome to hear repeated statements that the textile industry is "backward." This simply is not true—the textile industry,

from the standpoint of accomplishment of functional and artistic results in its products, is truly advanced. This is not to say that scientific research, as we now define it, has played much of a part in this advancement. Indeed, only in recent years has research made a visible imprint on this great industry, and only a small segment of the industry understands that the days of art and invention are on the wane and that basic science must now be called upon and supported. On the other hand, any objective scientist who concerns himself seriously with textile problems can only conclude, most humbly, that many great minds, without formal scientific training, can accomplish wonderful things over a long period of time.

Principles of Fiber Survival

We hear a great deal these days about the "battle of the fibers." In reality, there is no "battle of the fibers"; it is only those who are marketing them who are involved in wars of words. Any fiber must meet the three basic requirements—availability, reasonable price, and superior properties for at least one important application—if it is to survive. Silk fell by the wayside mainly because of a politico-economic situation which made it unavailable at a reasonable price. Then, with the development of nylon, with its good properties in the important women's hosiery field, silk faded to a position of minor consumption in luxury fabrics. Silk is still an excellent fiber, but it costs over $4.00 per pound, against $1.70 for nylon. Extrapolation of the sad history of silk to the futures of wool and cotton hardly seems justified in the light of our present knowledge, although the attenuation of raw wool production in this country must be considered a long-range disturbing factor for that fiber.

Difficulties Facing the Synthetic Fiber Chemist

It is quite natural for a chemist who is unacquainted with the details of textile technology to predict that synthetic fibers will soon largely replace wool and cotton in apparel fabrics [1]. After all, the march of synthetic substitutes upon natural materials is just a matter of history. But this generalization must not be applied too broadly to the basic materials of the textile industry. Why?

First of all, the relationship between the properties of the high-polymer molecule of a fiber and those of the finished fabric is very tenuous. It is much more complicated, for example, than would be true for a vinyl polymer employed in a transparent raincoat material. In fact, by proper choice of yarn and fabric construction and by use of chemical and physical finishing tricks, the chemical nature of the fiber can sometimes be almost completely ignored as regards the properties of the finished fabric. Furthermore, there are certain subjective qualities, such as hand and drape, that must be met in an apparel fabric which thus far defy quantitative description. Hence, it is not a simple matter to establish what properties a synthetic fiber should have in order to give fabrics with predetermined characteristics.

Secondly, any synthetic fiber must initially be processable with existing textile machinery which has been developed over a period of centuries for use with the natural fibers. The investment in machinery for a given mill is very great and major changes cannot be made overnight, no matter how promising the new fiber that requires these modifications may be.

Thirdly, the old fibers have some amazingly good properties which are hard to achieve in a synthetic fiber at a reasonable price. There is every reason to expect, moreover, that the principal natural fibers will not rest on their laurels, for there is a rapidly increasing tendency to apply to them the elixir of research. This has already resulted in important improvements in their properties without serious increases in cost. Thus, the synthetic fibers face a constantly improving set of natural competitors, some of which can be produced at prices that are below the raw materials costs of the acrylic and polyester fibers.

In general, then, when the chemist asks the textile industry what it wants in the way of fiber properties and costs, he may get some learned answers, but, after he goes to work, he often finds that these answers are incomplete, inaccurate, and even very misleading. Thus, he decides that he will have to find out for himself what the industry needs, and this is costly in time and money. After his laboratory and pilot-plant ordeals, he finds that he must go back to the textile industry to try out his creation in full-scale operations. Finally, he must submit his product to the fickle consumer who wields the "big stick" which decides between the success and failure of the fiber chemist.

Purposes and Limitations of This Paper

It is the purpose of this paper to discuss the weaknesses of the man-made fibers rather than their manifold advantages, which have been so often lauded. In this critical analysis, however, due recognition will be given to the remarkable progress which has al-

ready been made in removing or minimizing their deficiencies. This approach, it is hoped, will be constructive as well as objective, and thus may justify certain conservative prognostications.

Since the fiber field is extremely broad, the present discussion will be confined, as much as possible, to applications of fibers to clothing and decoration. Occasionally it will be necessary to digress into the fields of industrial fabrics—tire cord, filtration fabrics, felts, etc.—for a fiber which may find its sole application today in an industrial fabric or cord may be just "trying its wings" before a flight into the more glamorous world of clothing and decoration.

Continuous-Filament *versus* Staple-Fiber Products

There are two distinct phases of fiber physics and chemistry—that devoted to the continuous filament *à la* silk, and that devoted to staple fiber *à la* wool and cotton. They are both very important, but quite distinct. By far the greatest encroachment upon the domain of the natural fibers has been made by continuous-filament viscose rayon and acetate. As one result, silk (the only natural continuous-filament fiber) is practically out of the textile picture. However, continuous-filament high-tenacity viscose rayon has replaced, qualitywise and costwise, good-quality cotton (a staple fiber) in tire cords.

The greatest research activity at present is in the field of the staple fibers. At first thought, it seems a bit foolish to produce a beautiful continuous-filament material and then break it up into one- to four-inch lengths. However, as long as the consuming public demands suiting materials which are warm and "wooly" in appearance and feel, or pillow cases from which their heads do not slide during sleep, the development of synthetic staple fibers will continue to be a tremendously important field. Staple fibers must meet several requirements beyond those applying to a continuous-filament fiber. For example, a staple fiber generally must be crimped in some manner, and the character of its surface is important in determining its behavior in processing and the nature of the yarns made from it. The bulking power of a staple fiber depends somewhat on its specific gravity but also strongly on the shape of the fiber cross section.

General Problems Applying to Any Man-Made Fiber

We have already set forth the requirements for success of any fiber—availability, reasonable price, and superior properties for at least one important application. Suppose now, while keeping the first two requirements firmly in mind, we consider the third by tabulating and discussing very briefly the general problems involved in developing any man-made fiber. The problems which relate directly to the fiber itself and the yarn are concerned with uniformity, strength, extensibility, resilience, moisture absorption, dyeability, chemical stability, and surface characteristics. The problems which manifest themselves most often in the fabric are concerned with mechanical stability, soiling, ironing range, local melting, flammability, pilling, static electrification, wicking, abrasion, wrinkle-resistance, crease-retention, and tactile qualities. This list is far from complete, as any experienced textile technologist will testify, and it refers primarily to product rather than processing problems.

Fiber and Yarn Problems

Uniformity

There are still a few chemists who will say with a straight face that any synthetic product will, of course, be perfectly uniform—certainly much more uniform than the corresponding natural product. Such idealism is commendable, but let the practical chemist beware when he attempts to turn out this paragon of uniformity in a synthetic fiber, particularly one of the staple variety. It is probably true that a given autoclave supplying a single spinning unit can deliver a more uniform product than a sheep can. But take several autoclaves and several spinning units and then impose the tow-breaking and crimping operations upon the already complex set of chemical and physical operations; sometimes the sheep would be justified in a chuckle of superiority. Of course, sheep are not given to chuckling—they only say "baah," but sometimes this sounds strangely like remarks made by chemists when they survey the test data on their fibers.

Strength, Extensibility, and Resilience

Strength, extensibility, and resilience are all elements of the complicated matrix of mechanical performance which is at last getting the concentrated attention of chemists and physicists [6]. Achievement of high tenacity, particularly under "wet conditions," has undoubtedly been overplayed, but no great harm has been done for it is relatively easy in a synthetic fiber to "cut back" in tenacity in order to obtain the proper balance of extensibility and reversibility of

mechanical behavior known as "resilience." It is most encouraging to find many chemists who understand that the initial stress-strain curve for a fiber has relatively little significance in regard to actual processing and product qualities; they now insist on data obtained from repeated cycling studies in order to learn *what the fiber is* rather than *what it was* [2]. It is also interesting to find that the policy of a few years ago of matching the stress-strain curve of a natural fiber is gradually changing into a tendency to produce a fiber with the "desired mechanical properties," which may not necessarily be those of any particular natural fiber.

Moisture Absorption

It will require many years of difficult and expensive physical, physiological, and psychological research to learn just how important moisture absorption is for a fiber intended for use in apparel fabrics. This is certainly the sixty-four million dollar question for the synthetic fiber producing industry, for moisture absorption is the one quality which has been difficult to achieve in the newer synthetics without sacrifice of their remarkable properties of wrinkle-resistance and launderability. However, even though it finally develops that a reasonable amount of moisture absorption is desirable, the hydrophobic synthetics must not be counted out, for there is always the possibility of blending hydrophobics with hydrophilics, natural or synthetic. Recognizing this possible solution to the problem, it would seem that those who are attempting to develop fibers with moderate moisture absorption but marginal mechanical properties should proceed with care.

Dyeability

Dyeability is intimately associated with moisture absorption. However, it must not be assumed that dyeing a hydrophobic fiber will always be the difficult problem that it is today. It must be remembered that an entirely different type of dyeing and a whole new set of dyes had to be developed for acetate rayon, which occupies a moisture absorption position midway between the hydrophilic and hydrophobic fibers. The problem of dyeing a fiber is just a matter of opening up a structure by swelling, diffusing the coloring molecule or molecules into that structure, reacting the coloring molecules with certain chemical sites or entrapping them physically within the network, and, finally, holding them there by chemical or physical means. In the case of vat dyes, a chemical reaction goes on within the fiber to produce the color, *in situ*. Without departing from these old principles, already great strides have been made toward solving the dyeing problems introduced by the hydrophobic fibers. For example, high-temperature dyeing techniques have shown considerable promise, and one major manufacturer has introduced a "dope-dyed" acetate upon the market. "Dope dyeing," which is simply the introduction of the colorant into the spinning solution, is not new in concept, but now offers real advantages for difficult-to-dye fibers blended in various proportions in a yarn. Nevertheless, it must be acknowledged that the dyeing problem for the hydrophobics, not to mention blends of the hydrophobics with hydrophilics, is a major headache and will continue to be for some time.

Chemical Stability

The chemical stability of textile fibers is a broad subject for it involves not only simple chemical reactions with liquids and gases but also those catalyzed by light. Some of the newer synthetics—Saran, for example—have remarkable resistance to solvents. Others are acid- and alkali-resistant to a high degree. Some go to pieces rather badly in outdoor weathering, while others—notably, Orlon—are exceptionally good in this respect. Obviously, the synthetics can be designed specificially to withstand various chemical environments, and it is highly improbable that any one fiber will be developed which will be good under all chemical conditions.

Surface Characteristics

The attainment of suitable surface characteristics has been a problem from the early days of viscose rayon, when it was found necessary to incorporate a pigment such as titanium dioxide to reduce luster. Aside from appearance, the fiber surface is important because it relates to fiber slippage in a staple yarn and possibly to the related pilling problem. No man-made fiber has yet been developed which will felt or full like wool, and it seems unlikely that wool-type scales will be reproduced in the man-made fibers by any of the processes employed thus far. It is possible to substitute tight weaves for the fulling operation and obtain fabrics that are roughly similar to those produced by the old process. Furthermore, blending wool with a smooth-surfaced synthetic fiber will permit a certain amount of fulling, but it does not appear that any of the man-made fibers has much of a future in nonwoven felts.

Fabric Problems

Mechanical Stability

The problem of obtaining mechanical stability in fabrics—*i.e.*, ability to maintain dimensions under varying conditions of temperature, humidity, and distortion—has been with us for a long time. Tightly woven cotton fabrics are stabilized very effectively by the Sanforizing process, and there are various processes which are employed to reduce the felting shrinkage of woolen knit goods. There are any number of resin finishes and cross-linking treatments for viscose rayon fabrics. In approaching the stability problem with the hydrophobic fibers, however, temperature rather than moisture effects must be combatted. In general, these fabrics must be "set" at a temperature higher than that which they will later experience.

Soiling

The problem of soiling is rather complex. Both the tendency to soil and the ease of soil removal must be considered, and the two effects are not always simply related. While a smooth hydrophobic fiber may be easy to clean under some circumstances, sometimes the reverse is true. For example, nylon lace picks up the flat graphite particles found in such profusion in a lace mill and holds them tenaciously. In fact, a special water-soluble sizing had to be developed for nylon lace yarns which could be washed off with the graphite soil after weaving the lace. Electrostatic effects with the hydrophobic fibers have proved very conducive to soiling. Hence, the soiling and soil-removal problems are very important for the man-made fibers and deserve continuing attention. It is well to point out also that every new fiber which appears in clothing or domestic fabrics introduces a host of problems for the laundry or dry cleaner. It would be relatively simple if the new fiber were used alone, but the fact that most of them now occur in blends with natural fibers and other man-made fibers makes the laundryman's and the dry cleaner's lives interesting but often unhappy. Unfortunately, there seems to be little hope for these poor fellows since new fibers and combinations of fibers are appearing with increasing frequency.

Ironing Range

It is well known that some of the man-made fibers, such as acetate rayon and Dynel, have rather low softening points and must be ironed at relatively low temperatures. Although some of the hydrophobic synthetics are quite satisfactory in this regard, it is interesting to find that the effective ironing temperature depends rather strongly upon fabric construction and can be increased substantially by blending the offending synthetic with another material of higher softening point.

Local Melting

Another problem introduced by the thermoplastic types of synthetic fibers is their property of melting to form a small hole in a garment upon which a spark falls from a pipe or cigarette. Even Dynel, which does not support combustion, is subject to this difficulty. Obviously, some alleviation of this defect can be achieved by developing fiber materials with higher melting temperatures, but there is undoubtedly a limit beyond which it would not be practical to go. Quig and Dennison [7] have shown that blending Dacron with wool or viscose rayon solves the local melting problem in the resulting fabrics. In fact, only 10% of viscose rayon in the blend seems to do the job, so definite progress is being made.

Flammability

The flammability of a fabric depends not only upon the fiber used but also upon the fabric construction. For example, a "brushed fiber" type of fabric is very dangerous, even when the fiber used is a slow-burning type such as wool. Some man-made fibers do not burn at all—notably, glass, Saran, and Dynel. Most of the newer hydrophobic fibers are flammable, however, and have a nasty habit of melting and then burning. Flammability will continue to be a problem with these fibers, and again it may prove necessary to reduce the tendency to burn by blending with other fibers, although proper choice of fabric construction and finish seem to be the most fruitful approaches at present. Military needs for nonflammable fabrics are very great, of course, and it seems safe to say that this will lead to progress.

Pilling

Pilling is another fabric difficulty which has been intensified with the introduction of the newer synthetics. It is really not a new problem, for pilling takes place to some extent with wool and viscose rayon, but, because those fibers are so much weaker than nylon, Dynel, and Dacron, the protruding fibers

break off before the balling up or pilling reaches a serious stage. Pilling takes place also with cotton, particularly cotton gauze, so it is not necessarily true that thermoplasticity or a high degree of creep is an important factor in pilling. Apparently some of the hydrophobic fibers—Orlon, for example—pill much less than others, and this has been attributed by some to surface roughness which would tend to reduce fiber migration. However, others have concluded that this lower tendency to pill exists as a result of the lower tenacity of some of the staple fibers now on the market. Obviously, less pilling will be observed with a heavier denier fiber or a longer staple, but this is not comforting when a fine short-staple fiber is desired for other good reasons. It is a little difficult to judge the progress being made in solving the pilling problem, but it appears from the few published data [7] that relatively little has been accomplished by blending with wool.

Static Electrification

Static electricity is not exactly a new problem in textile processing, and, under very dry conditions, static electricity has been known as a product problem also. However, the hydrophobic synthetics are intrinsically better dielectric materials than the old fibers, and, because of their low moisture absorption, they generate reasonably large quantities of charge even at high humidities. From the product angle, this static generation is quite serious since it results in unsightly dust collection on dark-colored fabrics under conditions of wear and in lint collection during laundry drying. There is also the clinging effect of women's dresses which results from static generation; this provides entertainment for the opposite sex, but the women don't seem to like it. The pyrotechnic display which sometimes occurs with a hydrophobic fiber blanket is particularly effective and spectacular since it occurs in the dark, but consumers who fear electricity or fireworks in any form are less amused than terrified. Already considerable progress has been made in developing antistatic finishes, and some are supposed to be stable to laundering and dry cleaning. However, they come off readily under conditions of garment abrasion, and cannot always be considered as completely effective. Several attempts have been made to blend the offending fibers with others which generate charges of opposite sign, and it has been stated that some success has resulted. At the present writing, however, it may be said that the static problem is still serious and that there is a need for intensive studies of the principles of triboelectricity as it relates to fibers.

Wicking

Wicking is another characteristic of the hydrophobic fibers. It is simply a matter of surface wetting which results in water penetrating rapidly through a fabric although the fibers themselves absorb practically no water. Wicking may be beneficial in the case of underclothing, but results in unpleasant sensations to the wearer of Dacron trousers who is caught in the rain. True enough, his Dacron trousers will dry out quickly after he comes indoors and there will be no loss of crease, yet he will have been uncomfortable, much more so than he would have been in old-fashioned wool pants. It would seem possible to modify wicking effects by surface finishes.

Abrasion

The abrasion-resistance of the man-made fibers ranges from fair for the cellulosics to outstanding for some of the hydrophobics. Large improvements in abrasion-resistance of woolen and worsted fabrics have been achieved by blending moderate amounts of nylon with wool, particularly in woolen hosiery yarns. This also results in important reductions in felting shrinkage. Hence, abrasion-resistance can hardly be considered a major problem of the hydrophobic fibers, and it seems possible that we may find, in the future, abrasion-resistance sacrificed in order to enhance other inversely related properties.

Wrinkle-Resistance and Crease-Retention

The hydrophobic fibers are outstanding in their capacity to confer recovery from wrinkling and crease-retention in apparel fabrics under moist conditions. Wool, of course, is quite satisfactory in this respect, as long as it is dry, but a blend of wool with Dacron, Orlon, Dynel, or Acrilan can generally be made to approach very closely the wrinkle and crease characteristics of the corresponding 100% synthetic fabrics. At the other end of the scale of man-made fibers, viscose rayon has very poor wrinkle-resistance and crease-retention, but may be improved greatly by resin and cross-linking treatments. The most recent of these are said not to produce loss of strength and tear-resistance as occurred with the earlier processes.

Tactile Qualities

Pleasantness to touch is a quality which varies greatly from fiber to fiber, but also is a function of the yarn and fabric constructions. Some of the man-made fibers have an unpleasant, clammy feel when used next to the skin, while others give a quite pleasant contact sensation. The use of crimped staple largely reduces these unpleasant tactile qualities, but this solution is limited to the loftier spun-yarn fabrics, which are seldom worn next to the skin. The effects of moisture absorption and heat of absorption also play roles in the tactile drama, and it seems that we shall have to wait until experiments on the comfort qualities of clothing yield more complete unambiguous information than is now available before we can predict the tactile futures of the various man-made fibers.

Classification of the Principal Man-Made Fibers

Thus far, we have enumerated and defined the technical problems which face the manufacturers of man-made fibers. We have also stressed the importance of economic factors and the distinction between continuous-filament and staple-fiber applications. We have further indicated that fiber morphology ranks in importance with chemical structure in determining chemical and physical behavior. But now suppose we classify the various man-made fibers, according to their chemical natures, into four broad groups: inorganic fibers, cellulosic fibers, protein fibers, and true synthetic fibers. This classification excludes several specialty fibers, such as those of the alginate type. Furthermore, we shall arbitrarily ignore the very new fibers which have not passed the pilot-plant stage and those which have had very limited usage. In any event, this classification will permit evaluation of the more important fibers by groups and perhaps later a cross-comparison among groups and thus a look into the future.

The Inorganic Fibers

Glass

Only one inorganic fiber is important for this discussion—the glass fiber, which is marketed both in continuous-filament and staple form. It is exceedingly strong in tension, having a tenacity of about 7 g./den. in the dry state (65% R.H., 70°F), which is reduced very little when the fiber is immersed in water. It ruptures at very low tensile strains (around 3%) and, since it is of circular cross section, it is not surprising that it is very brittle in bending. This characteristic was probably responsible for its poor fatigue characteristics in the early tires made from it, and almost completely excludes it from apparel applications. It is also very difficult to dye except by pigment tinting or by special techniques wherein a pigment is bonded to the surface with a resin, or a protein film is applied to the surface during manufacture which will take vat, direct, acid, or chrome colors. The glass fiber is almost completely hydrophobic, although a small amount of moisture is adsorbed on its surface. It has good electrical properties, and finds extensive application in high-temperature insulation. It is also truly flameproof, and thus is excellent for drapery materials, particularly those used in public places. It has chemical resistance to many acids and solvents, and thus is used extensively in filter cloths. Because of its great strength and good elasticity (it has a linear stress-strain curve), it is well suited as a reinforcing material for plastics, and special-purpose coated fabrics are made in various constructions. In particular, it has found military application in body armor and in structural members for aircraft.

The glass fiber seems to have very limited application for apparel fabrics, but this should not be very disturbing to its manufacturers because of the vast field of industrial uses for which it is so well adapted. It is not particularly high priced. Already glass textile yarns rank fourth in production and sales among the man-made fibers (behind viscose rayon, acetate, and nylon), and rapidly developing industrial requirements suggest that the production curve for glass fibers will continue to rise sharply.

The Cellulosic Man-Made Fibers

The cellulosic man-made fibers constitute about 20% of textile fiber consumption in this country. The textile industry has had long experience with them, and they have now reached a point of good consumer acceptance in many types of fabrics. They occupy a point of great economic advantage in that they are all based upon cellulose, a plentiful and cheap raw material. They are supplied both in continuous-filament yarns with varying degrees of orientation and in staple form, but may be considered under two broad classifications—regenerated cellulose types and cellulose derivative types. The regenerated celluloses include viscose rayon, cuprammonium rayon, and saponified acetate. Cellulose acetate is the only

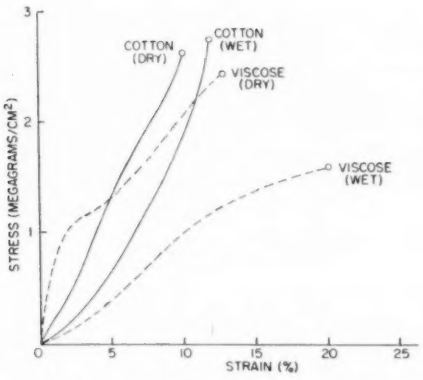


FIG. 1. *Stress-strain curves for viscose rayon and cotton.*

important member of the derivative family, although other derivative fibers have been found interesting—for example, cellulose propionate. The original man-made fiber, cellulose nitrate, no longer has textile applications, for obvious reasons.

Viscose Rayon

Viscose rayon is by far the most important of the regenerated cellulose fibers. It is distinctly hydrophilic, having a moisture regain of 13% at standard dry conditions (65% R.H., 70°F). Regular textile viscose is of rather low tenacity—1.5 to 2.4 g./den. dry and 0.7 to 1.2 g./den. wet. For many applications, however, this range of strengths is adequate, although it would be highly desirable to increase the wet strength in order to improve its mediocre laundering performance. The breaking extensibility ranges from 15% to 30% dry and from 20% to 30% wet. For applications requiring higher strength, viscose is supplied in higher tenacities and lower extensibilities produced by increasing the fiber orientation. About 38% of the total viscose rayon production in 1951 was of the high-tenacity filament type, which went into tire cord and related uses. High-tenacity viscose has dry tenacities ranging up to 4.6 g./den., with corresponding extensibilities at break as low as 8%. Loss of tenacity with increasing moisture content is not as great for the highly oriented viscose—about 50% drop from dry to wet conditions, as compared to 100% in the case of regular textile viscose.

All commercial viscose rayons are purposely degraded in the alkali cellulose stage to D.P.'s of 300 to 400 in order to have the proper viscosity for spinning the xanthate dope. Enhancement of mechanical properties is largely brought about by orientation achieved by stretching the fibers during or after spinning. Hence, the state of order of the cellulose of viscose rayon is very different from that of the native cellulose of cotton or wood-pulp fibers. As a result, the dry stress-strain curve for viscose rayon has a pronounced yield point not found in the natural cellulosic fibers (see Figure 1), and the over-all extensibility is greater for the textile viscose employed in this experiment, particularly in the wet state. The modulus or stiffness of the cotton fiber in the low-strain region is much lower than that of textile viscose under dry conditions, but this undoubtedly results from the unique spiral morphology of the cotton fiber. This failure to reproduce the stress-strain behavior of cotton in the viscose fiber should not be considered a great disadvantage; in fact, it may be considered most fortunate, for it makes viscose rayon one of the most versatile fibers at our disposal. In continuous-filament form it can be used in applications where silk was once supreme, and in staple form can be employed alone or in blends with wool, cotton, and other man-made fibers to give a host of widely varying fabrics.

The high moisture absorption of viscose rayon is an advantage in many respects. For example, viscose staple may be blended with many of the hydrophobic synthetics to induce body comfort, dyeability, higher ironing temperatures, freedom from local melting, and alleviation of the static electrification problem. Accompanying its high moisture absorption is its excellent dyeability. Viscose fabrics "can be dyed or printed with a wide variety of dyestuffs and to any degree of brilliance with color fastness properties to suit any need—and at very low cost" [5]. This hydrophilicity, however, is not an unmixed blessing, for with it there is the extreme swelling which contributes so much to the instability of rayon fabrics [7]. Viscose rayon is a "dead fiber," even under dry conditions, but when it is swollen it is extremely plastic and soft. Thus, it is not surprising that extensive work has been done to reduce its swelling and improve its resilience. Resin finishes and cross-linking treatments have been developed in recent years which are very effective in reducing fabric instability and inducing wrinkle recovery. But these processes must be carried out very carefully in order not to reduce the strength and tear-resistance. In fact, it seems safe to say that textile viscose rayon has a long

way to go before it will compete with dry wool or wet hydrophobic fibers in resilience. Yet, it is far enough along in this direction so that it may be blended with wool or the newer synthetics to yield fabrics with quite adequate crease-retention, wrinkle-recovery, and handle. At the same time, it has the capacity for inducing in blends other good properties inherent in its high moisture absorption and, most important of all, a substantial reduction in cost.

Viscose rayon offers no serious difficulties as regards ironing range, local melting, pilling, or static electrification. It is not outstanding in abrasion-resistance, nor are its tactile properties very good. Like cotton, it is quite flammable, but considerable progress has been made in reducing this deficiency. A number of surface treatments to produce flame-retardance have been developed, but perhaps the greatest success has been in the field of reacting the regenerated cellulose with inorganic salts.

It must not be assumed, just because viscose rayon is one of the oldest of the man-made fibers, that it is a static textile material subject only to a piecemeal patching up of its defects. Without betrayal of confidences, it can be said that several capable research organizations are well along in their quests for a quite different and highly improved type of regenerated cellulose fiber. It is interesting to note that French scientists have recently reported [4] a new type of filament viscose with a dry tenacity of about 6 g./den. and a considerably improved ratio of wet to dry tenacity. Here it appears that a means of spinning very fine viscose fibers with a much smaller reduction of the D.P. of the original cellulose pulp has been developed by recognition of the principle that the dynamic coefficient of viscosity increases much less rapidly than the static coefficient with increasing D.P. Obviously, the state of order of the cellulose of this fiber will be quite different from that of commercial viscose rayon, and the mechanical properties of the fiber should not be the same. Indeed, this was found to be true when we made some preliminary tests on this new fiber. As is seen in Figure 2, the stress-strain curve is almost linear, like that of cotton, and the effect of moisture has been reduced. It is understood that this new viscose fiber is showing great promise as a tire-cord material. However, the writer has seen a number of dyed and printed fabrics which approach silk very closely in appearance and handle. Thus, it seems that this new viscose has excellent dyeing properties and that the use of extremely fine deniers (0.5 denier or less) has resulted in a suppleness which counteracts the stiffening effect of the higher D.P. It should not be assumed that this new regenerated cellulose fiber is a panacea for all the ills of viscose rayon; indeed, this high-D.P. viscose may be quite unsuitable for staple-fiber applications. However, this development should be comforting to the chemist who dislikes having a perfectly good long-chain molecule degraded, simply to permit processing into the form of a fiber.

Cuprammonium Rayon

Cuprammonium rayon, sometimes referred to as "Cupra" or "Bemberg rayon," is another regenerated cellulose fiber. It occupies a relatively minor position today with respect to rayon made by the viscose process, but still is produced in quantity and finds application in knitted and woven wearing apparel, upholstery, and decorative fabrics. It is very similar in chemical structure and physical properties to viscose rayon, but the fibers are of circular cross section, as compared to the irregular star-shaped cross section of viscose. Furthermore, very fine fibers can be spun by this process, and there is less degradation of the cellulose. It is somewhat more expensive to produce than viscose rayon, and thus its future is doubtful, except for those applications where the circular cross section endows it with unique characteristics.

Saponified Acetate Rayon

Perhaps this interesting fiber, marketed under the name "Fortisan," should be included among the cellulose derivatives since it begins its life as a cellulose acetate fiber. However, after deacetylation under tension, it ends up as essentially regenerated cellulose. It is one of the strongest fibers known, having a dry tenacity of 7 g./den. which drops very little

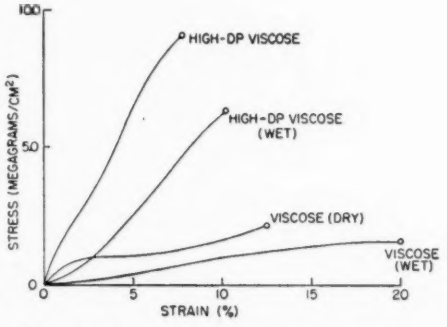


FIG. 2. *Stress-strain curves for viscose.*

—to 6 g./den. wet. It has a very low extensibility to break of about 6.5% under dry conditions. Consequently, its fatigue life in tire cord, like that of glass, has thus far been rather discouraging. It has found important applications, among them its use in continuous-filament yarns in nonrigid airship fabrics. It appears to have properties which should make it very useful in a number of other products, such as special types of sewing thread. Saponified acetate is very interesting to the scientist for it has tensile properties which are affected by moisture and temperature in a manner which strongly reminds one of native cellulose [3].

In common with all highly oriented regenerated celluloses, saponified acetate presents difficulties in dyeing and is rather expensive to produce. Yet, if it could be produced in a crimped staple, there would be reason to speculate about its possibilities as a competitor for the hydrophobic synthetics. Thus far, it has been marketed only as a continuous-filament yarn.

Acetate Rayon

Acetate rayon is second only to viscose in American consumption of man-made fibers. In fact, it stands first among the continuous-filament fibers. Acetate may be considered the ancestor of the newer hydrophobic fibers, for it is thermoplastic and has a considerably "livelier" handle in fabrics than does its cousin, viscose. Furthermore, acetate is on the borderline between the hydrophilic and the hydrophobic fibers, absorbing only about 6% moisture under standard conditions. It is not a particularly strong fiber. The regular variety has a dry tenacity between 1.3 and 1.5 g./den. and a wet tenacity ranging from 0.8 to 1.2 g./den. Its ultimate extension may be as high as 30% dry and 40% wet. The high-elongation type has an extensibility of as much as 50% dry and about 70% wet. A glance at the stress-strain curves of acetate (see Figure 3) gives a further suggestion that it is essentially a wool-like fiber. But here we are misled by properties deduced from the first stress-strain cycle; on repeated cycling, it is found that acetate behaves rather differently [2], exhibiting a much more pronounced progression of stress under dry conditions upon repeated cycling. Nevertheless, acetate is somewhat wool-like in behavior, and yields better wrinkle-recovery than untreated textile viscose in equivalent fabrics. It can be blended with wool and the hydrophobic fibers in much the same way as is customary with viscose.

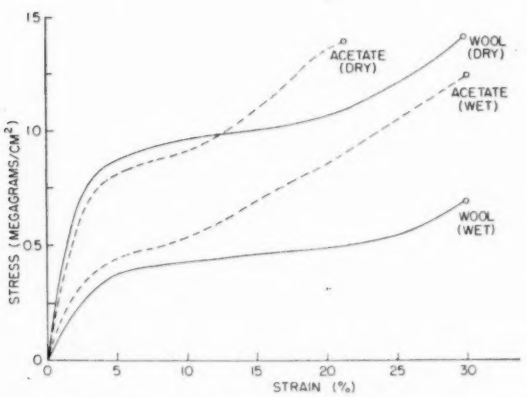


FIG. 3. *Stress-strain curves for acetate and wool.*

In keeping with its character as the ancestor of the modern hydrophobic fibers, acetate is not easy to dye. In fact, an entirely new set of dyes was developed for acetate. These are now proving useful for some of the hydrophobics. Recently, methods have been developed by which acetate can be colored with acid and vat dyes. Whether or not this will solve the atmospheric fading problem, which is characteristic of acetate, is not yet known but is a possibility. The dope-dyeing technique, previously mentioned, seems even more promising.

Acetate suffers from a number of minor ailments. For example, it is soluble in acetone, creates some static charge in processing, and is subject to the local melting trouble. It does not felt or pill, but it is very poor in ironing range. However, this problem seems to have been met over a period of years by an educational campaign directed at the housewife. In short, acetate appears to have enough good properties to counteract its weaknesses, and, because it can be produced at low cost, both in filament and staple form, will continue to be an important fiber.

The Protein Man-Made Fibers

A great deal of research effort has gone into the development of regenerated protein fibers. Most of this work was undertaken on a sound economic basis, for there are many protein waste products, such as chicken feathers, which offer a cheap and almost inexhaustible supply of raw materials. In spite of the originality of the experimenters and the expertness of their work, no self-sufficient regenerated protein fiber has resulted. In every instance, as far as we can learn, these fibers have been sadly deficient in

wet strength. Aside from certain protein fibers which have shown promise as brush bristles, only two types are on the market today. These are Ardil, the peanut protein fiber under development in England, and Vicara, the zein-based fiber of this country. This discussion will be confined to Vicara, with the thought that most of the problems which it faces are about the same as those for Ardil.

Vicara is marketed as "the fiber that improves the blend," and this is exactly what it is. As seen in Figure 4, the wet strength of Vicara and also its wet extensibility are too low to permit its use in fabrics without a stronger blending fiber. However, Vicara is extremely effective in blends with other fibers in producing loftiness in the yarns. It is produced only as a staple fiber, of course, and is not very expensive —about $1.00 per pound. It dyes by any number of techniques which are satisfactory for wool but, because of its smooth surface, does not felt. Thus, it is, "as advertised," a very useful blending fiber. It must not be supposed that, eventually, better regenerated protein fibers will not be produced. Already it is known that certain cross-bonding reactions can be made to take place which materially increase the wet strength. However, most of them involve the use of materials which produce toxicity in the treated fiber. Eventually, a satisfactory regenerated protein fiber will be produced, and this may cause us to revise our whole concept of the man-made fiber field. Certainly nature produces a wide variety of protein fibers. For example, compare the behavior of wool and a collagen fiber, teased from a piece of tanned leather, shown also in Figure 4. The collagen fiber is highly extensible, but yields a linear stress-strain curve in the dry state.

The True Synthetic Fibers

Finally, we come to the true synthetic fibers, which are made of coal, water, air, petroleum, limestone, and other things not ordinarily found among the sweepings of a well-regulated mill. For the purposes of this discussion, the more important members of this group are the polyamides, the polyacrylics (including copolymers of acrylonitrile with vinyls and acrylates), and the polyesters. Only brief consideration will be given to the polyvinyl, polvinylidene, and polyethylene fibers. All of the true synthetics are strongly hydrophobic, except possibly nylon, which absorbs between 3% and 4% moisture under standard conditions. Hence, their mechanical properties change very little upon immersing in water and they have excellent durability in laundering, and some of them have remarkable wrinkle-resistance and crease-retention properties. But their hydrophobicity, as previously pointed out, introduces many problems, particularly difficulty in dyeing and static electricity.

Polyamides

Nylon, the first true synthetic fiber, is the only one of real commercial importance today. The various Perlons, also of the polyamide type, are produced on the European continent, and at least one major manufacturer plans to make a Perlon fiber in this country. However, only the ordinary nylon now on the American market will be discussed here. It is a melt-spun fiber with unusually high tenacity (7.5 g./den. in its highly oriented form). It has a very high extensibility and a uniquely low modulus at low strains. Its resilience characteristics are good, although the time of recovery from large strains is rather high. Its first great success was the replacement of silk in women's hosiery yarns, where, of course, it is used in the continuous-filament form. Its great strength and ability to absorb energy, dynamically or statically, has made it useful in any number of industrial and military applications—thread, ropes, tire cord, sailcloth, parachute shrouds, body armor, etc. In continuous-filament form it has wide acceptance in satins, taffetas, marquisettes, and women's underwear fabrics, particularly tricot fabrics. It finds a limited use in men's shirtings, where its quick drying is an attraction for the traveler. In general, however, a nylon shirt is judged uncomfortable in hot weather, possibly because of low moisture absorption.

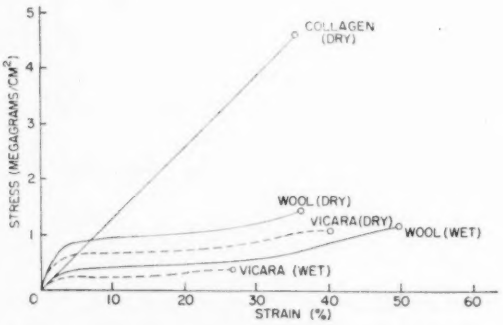


FIG. 4. *Stress-strain curves for wool-like fibers.*

As with most of the synthetics, the staple form of nylon is made with lower orientation and, hence, lower tenacity—about 4.5 g./den. It can be crimped by several methods so that it can be blended with other fibers on the woolen, worsted, and cotton systems of spinning. Blended in an amount of only 30% in a woolen hosiery yarn, it conveys an amazing resistance to wear and reduces felting shrinkage greatly. It is also used in suiting materials, but does not appear to have quite the potential of the acrylics and the polyesters for improving wrinkle-resistance and crease-retention. Neither does it have the bulking power of some of the other synthetics, in spite of its low specific gravity (1.14), for it has the circular cross section characteristic of a melt-spun fiber.

The dyeability of nylon certainly does not compare with that of viscose rayon, cotton, or wool. However, techniques have been worked out which permit the use of acetate, acid, and chrome dyes as well as some direct, vat, azoic, and basic colors. It has a reasonably good chemical stability, although it loses strength gradually upon exposure to sunlight and goes to pieces in acids. Continuous-filament nylon has a cold unpleasant feel to the skin, and some types of fabric have a decidedly limp hand. While nylon has proved a good replacement for silk in hosiery yarns, it is sadly deficient in scroop (tendency to rustle), which seems to be desirable in women's dress fabrics. In common with the other hydrophobic fibers, it offers problems in soiling, local melting, flammability, static electrification, and wicking. It has absolutely no felting properties, which constitutes both a deficiency and a great virtue.

To summarize the situation with nylon, it is the pioneer synthetic which, without major change, has an assured future. It has largely replaced silk, but it is doubtful that wool and cotton will suffer much from its introduction unless its price can be brought down appreciably.

Polyacrylics

The polyacrylic fibers will be discussed as a group since they have many properties in common. They are all strongly hydrophobic, with moisture regains ranging from 0.3% to 2% at standard conditions (65% R.H., 70°F). Only two varieties may be considered to be in full production—Orlon, which is essentially polyacrylonitrile, and Dynel, copolymer of acrylonitrile and vinyl chloride. They are both solvent-spun and have low specific gravities; thus, they have high bulking power. Orlon is made both in continuous-filament and staple forms, and Dynel, a staple fiber, has a continuous-filament counterpart known as "Vinyon N." Both are superior to nylon in tactile properties and, in the staple form, have a more wool-like mechanical behavior. Both have excellent resistance to solvents, alkalis, and acids, and thus have many industrial applications. As with all the true synthetic fibers, the degree of orientation may be varied considerably to give the properties desired. For example, continuous-filament Orlon (tenacity about 4.5 g./den.) is so oriented that its stress-strain curve practically coincides with that of a high-quality silk, while staple Orlon (tenacity about 2 g./den.) has stress-strain behavior approximating that of dry wool [7]. Possibly the low tenacity of staple Orlon partially explains its superiority over other hydrophobic fibers in resistance to pilling. Orlon has one outstanding property—amazing performance in outdoor exposure. On the other hand, it is flammable after melting; Dynel is the only organic synthetic fiber which does not support combustion. Both Orlon and Dynel suffer from the difficulties inherent in hydrophobicity—difficulty of dyeing, static electrification, and discomfort in underwear and shirting applications. Because they are thermoplastic, they offer problems in low ironing range (especially true for Dynel) and local melting. Nevertheless, staple fibers of Orlon and Dynel have enjoyed considerable success in blends with wool for apparel fabrics. They also have definite possibilities in launderable blankets and certain types of pile fabrics.

A number of other acrylic fibers with interesting properties have been developed, but are not yet in full production. Undoubtedly, some of these will become important, but they are difficult to discuss at present because of the decidedly fluid state of their compositions and properties. Two of them are particularly promising from the standpoint of dyeability—Acrilan, which is a copolymer of acrylonitrile and vinyl acetate, and X-51, a copolymer of acrylonitrile and methyl methacrylate. The latter is unique among the acrylic fibers because of the fact that it is wet-spun, which is said to introduce a microporosity which benefits dyeing and surface properties. Both of these fibers have shown promise in small-scale textile experiments, but it is too early to venture an evaluation of either of them.

To sum up the situation for the polyacrylic fibers, they seem to have definite possibilities, particularly

in the woolen and worsted fields, where they are competing with wool, the most expensive of natural fibers. They fall far short of wool in many of its properties, but have certain distinct advantages in their greater tenacity and unusual wrinkle-resistance and crease-retention in the wet state. Their futures, then, will depend upon the success of those who are working so hard to correct their deficiencies and reduce the costs of raw materials and processing into fiber form. Stress-strain curves for the acrylic fibers, nylon, and Dacron (all in staple form) are shown in Figure 5.

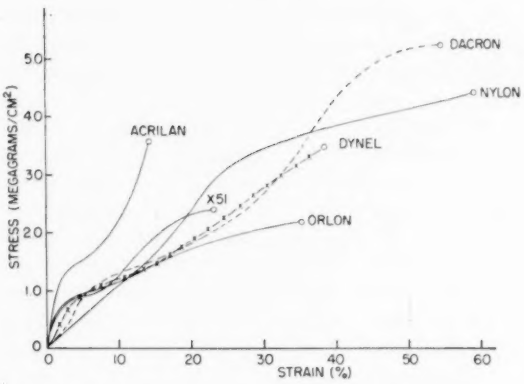


FIG. 5. *Stress-strain curves for staple synthetic fibers (dry).*

Polyesters

There is only one commercially available polyester fiber—polyethylene terephthalate—which is known as "Dacron" in this country and "Terylene"in England. It absorbs only 0.4% water under standard conditions, and is supplied in staple form with a tenacity of 5 g./den. It suffers all the ills which can be associated with a strong hydrophobic thermoplastic fiber. It is outstanding, however, in endowing wrinkle-resistance and crease-retention to suiting fabrics, either blended with wool or alone. It has also proved to have very good fatigue properties in continuous-filament tire cords, but it appears that its immediate future will be as a staple fiber in apparel uses. As with the polyacrylics, a great deal of effort will have to be expended in correcting its technical defects and reducing costs of raw materials and processes.

Other Synthetic Fibers

There are a number of other synthetic fibers which cannot be classified as polyamides, polyacrylics, or polyesters. Since none of them has at present much importance in apparel uses, they will be discussed very briefly. Polyethylene fiber is made commercially on a small scale, and is used in upholstery and in shoe and handbag fabrics. It is completely hydrophobic, but has a rather low tenacity ranging from 1 to 2.5 g./den. Unfortunately, it has a low melting point—between 230° and 250°F—which limits its usefulness, but it can be made at relatively low cost. There are a number of vinyl fibers which are of interest primarily for chemical applications. One of these, Vinyon HH, is produced in quantity. The vinyl-vinylidene chloride copolymer fibers—Saran, Velon, etc.—are produced commercially in monofilament form, and find wide application in upholstery fabrics and window-screening. They have also been spun as fine continuous filaments, which may sometimes be found useful in apparel and drapery materials. Fibers have been spun in this country from polyvinyl alcohol insolubilized by a formaldehyde treatment, and such fibers are being produced commercially in Japan under the name "Kuralon." They are being used in apparel fabrics, but do not appear very promising because of the poor resilience of the fiber, which gives a very dead hand. Kuralon fibers, which we have examined, have the peculiar property of dyeing a deeper shade in the central portion of the fiber. This results, of course, from the failure of the formaldehyde to diffuse to the fiber axis within the allotted reaction period.

Conclusions

On the basis of information which we now have, it seems quite safe to conclude that the synthetic fibers will continue to encroach more and more upon the domain of the natural fibers in industrial fabrics where the principal demands upon a fiber are availability and performance per dollar, and the fickle yardsticks of style, subjective reaction, and promotion play minor roles. The situation in the apparel and decorative fabrics fields, however, is much more difficult to analyze because of our incomplete knowledge of the technical requirements of a fiber in clothing, the complicated economics governing the fiber raw material to finished garment transition, and inability to predict consumer whims of the future. It is encouraging to note that we are making some progress in our attempts to understand performance requirements of

fabrics in terms of fiber properties. Our knowledge of the economics of textiles, unfortunately, does not appear to be increasing very rapidly, and it seems that progress in this vital field will require the combined efforts of economists, scientists, and political theoreticians. The future desires of the consumer are almost completely unpredictable. For example, in these days of air-conditioned buildings and automobiles, it is quite possible that madame may find herself required, by the dictates of style and comfort, to attend the theatre attired in a brief "Bikini." This would be no more upsetting to the fiber picture than was the decision of thousands of American males to go about without hats and purchase suits without vests. Then there was the instance where the popular movie hero peeled off his shirt, revealing no undershirt beneath; thousands of red-blooded men thereupon followed suit and found themselves quite comfortable, except perhaps at football games. But even football games are being observed these days on a television screen, and the need for a male undershirt is becoming vanishingly small.

Obviously, if we are to prognosticate the apparel future of the man-made fibers, we must blind ourselves to the possibilities of radical changes in economics and consumer reactions. Suppose, then, we consider the possibilities in the two great fields now dominated respectively by cotton and wool.

Cotton has already lost two major battles. A large part of its consumption in bagging materials has been taken over by paper. Most of the tire cord used today is of high-tenacity viscose rayon, replacing cotton in what was formerly its greatest single application. In spite of these inroads, more cotton is being consumed today than ever before and, in view of the extensive research effort now being expended on cotton to improve it and extend its uses, the cotton grower would seem secure for some time. Although the current price of cotton is limited by government controls, it is still a relatively cheap fiber which certainly can compete with the newer synthetic fibers. At the present time, however, staple viscose and acetate are selling at a slightly lower price, and they must be reckoned with, property for property, in predicting the future of cotton in apparel fabrics. Acetate does not seem a likely competitor against cotton on the basis of its much lower tenacity and other mechanical properties which resemble those of wool much more closely than those of cotton. Viscose staple is definitely a threat, however, and seems bound to replace cotton in certain applications. Nevertheless, cotton is still a superior fiber in many respects, and its price can be brought down by increased use of mechanical harvesting techniques. Furthermore, the uses of cotton are being expanded—for example, its use in carpets, where its low cost with respect to wool makes it a very interesting raw material. Assuming a monatonic character for the continually improving standard of living in this country, it seems safe to conclude that the total consumption of cotton will be greater ten years from now than it is today, perhaps not much greater but certainly not less. This is not to say that the man-made fibers will not find acceptance in many products now predominantly woven with cotton yarns. Undoubtedly they will, but it is predicted that ten years from now cotton will still be "king of the fibers" on a poundage basis, although cotton may drop percentagewise in consumption.

When we shift our scrutiny from cotton to wool products, the whole picture changes since wool is a *costly* natural fiber, as compared to cotton. At the outset, then, it appears vulnerable to substitution by the man-made fibers. Indeed, this is true and must be considered a "first principle." It is very difficult to establish a minimum price for raw wool which would permit reasonable profits to the grower and dealer. Moreover, it is hard to predict the availability of wool, for the sheep also produces meat which will bring a good price. Thus, a sheep farmer may decide to shift his interests in the direction of fat lambs rather than good yields of high-quality wools. There actually has been a tendency of this sort, both in this country and the British Dominions in recent years, which has brought about a decreasing supply of the finer wools, relative to the medium wools which are grown by the meat-producing types of sheep. The high price of wool and the uncertainty of its availability in various grades are serious, but the possibility of fluctuations in its price is most unfortunate. This has caused great distress among wool manufacturers. Perhaps the greatest benefit which the wool textile industry will receive through the introduction of the man-made fibers will be a stabilization of wool prices. But, granted that the wool fiber is expensive, is it worth what it costs? Apparently it is. In fact, no man-made fiber has ever approached it in all-around quality, except possibly in tropical worsteds. Some of the hydrophobic fibers, notably Dacron, have been blended with it to enhance its

wrinkle-resistance and crease-retention under moist conditions. Nylon has been blended with wool to give greater abrasion-resistance and reduction in felting shrinkage. Vicara has been blended with it to give enhanced loft. In nonwoven felts, the wool fiber has found itself among many and varied neighbors, but has never profited from the association. But here let us pause; this is the point at which it would seem that wool might be called the "iron" of the outerwear field which would serve as the base material for textile alloys of the future. In fact, the newer synthetic fibers could assume great stature in this role without other applications, and their use probably would result in expansion of the applications and markets for wool. It must not be assumed, however, that wool occupies a completely secure position. It is quite possible, for example, that some relatively cheap hydrophilic man-made fiber might be blended with a wool-like hydrophobic fiber to give fabrics with reasonably good dyeing properties and excellent wet strength and resilience. It is doubtful that such fabrics would have the luxurious handle of a fine 100% wool worsted, but, if the hydrophilic blending fiber were viscose rayon or a fiber made of a derivative of amylose, they might be produced rather cheaply. The possibility of such a union between a cheap hydrophilic and a wool-like hydrophobic fiber would seem to be the major threat to wool in apparel fabrics, on the basis of present knowledge.

In conclusion, and in departure from the enjoyable realm of speculation which the title of this paper permitted, it does appear that the field of fiber research is rather interesting. It would seem that the principal natural fibers—cotton and wool—may be with us for quite some time, perhaps for a very long time. All of the man-made fibers have wonderful futures, provided they meet the three basic requirements—availability, reasonable price, and superior properties for at least one important application.

Literature Cited

1. Adams, R., *Science* **115**, 157–63 (1952).
2. Dillon, J. H., *Ind. Eng. Chem.* **44**, 2115–22 (1952).
3. Dillon, J. H., and Prettyman, I. B., *J. Applied Phys.* **16**, 159–72 (1945).
4. Drisch, N., and Soep, L., "Fundamental Improvements in Regenerated Cellulose Structure," paper presented at Annual Meeting of Textile Research Institute, N. Y. C., Nov. 17, 1952; TEXTILE RESEARCH JOURNAL (in press).
5. Goldberg, J. B., *Ind. Eng. Chem.* **44**, 2169–75 (1952).
6. Hamburger, W. J., TEXTILE RESEARCH JOURNAL **18**, 102–13, 705–43 (1948).
7. Quig, J. B., and Dennison, R. W., *Ind. Eng. Chem.* **44**, 2176–83 (1952).

Review of Textile Research and Development During 1952

Edited by

Richard Steele, Corneil Messler, and J. H. Wakelin

Textile Research Institute, Princeton, New Jersey

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Review of Textile Research and Development During 1952

Introduction

This paper is a review of the literature published during 1952 in the fields of textile research and development. The arrangement of the subject matter differs from that of the earlier *Reviews* in this series. The discussions of the details of advances in the various fields of interest have been eliminated, and a much more analytical division of the literature references has been made. However, the important aspects and trends in research and development, as evidenced by the work published in scientific and technical journals in the United States and abroad, have been outlined in a prefatory article. This preface, together with the titles of the individual papers under the various subject classifications, is intended to provide a concise but reasonably complete guide to the 1952 literature of textile research. It is hoped that this arrangement will make the *Review* more useful to textile scientists and technologists as well as to executives concerned with the planning of textile research or the industrial application of the products of this research.

Although these changes in format have helped to keep the *Review* to a manageable size, the actual number of references cited has increased. In the initial selection of papers for this 1952 *Review*, there were almost a thousand references which the editors have not included here. Some of these were of borderline interest to the textile field; others concerned some textile subjects systematically omitted. As in earlier years, the patent literature has not been reviewed.

Every effort has been made to insure the accuracy of the literature citations. Where journals have not been available for checking references brought to our attention by abstract journals, the abstract references have been included. Many articles in the Russian and Japanese languages also have references to English language abstracts even though the original journal was the source of the citation.

The task of searching the literature and making the original selection of papers for this *Review* was carried out by the following members of the technical staff of the Institute: H. M. Burte, T. F. Evans, C. Messler, D. J. Montgomery, R. F. Schwenker, Jr., R. Steele, R. K. Toner, H. Wakeham, J. H. Wakelin, and H. J. White, Jr. The detailed and painstaking task connected with the bibliographic work has been most ably done by Mrs. Charles Rosenblum. The Institute wishes to express its appreciation to the Office of Naval Research for its support of part of this work and for permission to publish the *Review*.

Trends in Textile Research and Development

Activity in a given field of science is frequently stimulated by the availability of new tools or techniques or by technological demands for more information in a particular area. Both of these factors are apparent in the reports of textile research and development published during 1952. The influence of these stimuli is superimposed upon a continually growing emphasis on research in this industry. If the business conditions of the textile industry in the last two years have had an adverse effect on research activity, it is not apparent in the number of papers published. Reliance on research and experimentation is becoming increasingly characteristic of the textile industry.

Of the new tools which have become generally available to science since the war, one which seems to be making a considerable contribution to our knowledge of the characteristics of fibrous materials is the electron microscope. This may be due in part to the fact that it so perfectly complements older, well-explored techniques such as optical microscopy and x-ray diffraction. Electron microscopy has

therefore been particularly valuable in elucidating the fine structure of cellulose and protein fibers, and numerous papers describing its applications to these problems are cited in this *Review*. Despite the considerable activity in this field, there is good reason to believe that the possible contributions of electron microscopy to our understanding of fibers is far from exhausted.

The development of more sensitive instruments for measuring the properties and behavior of single fibers and fiber assemblies has stimulated work in a number of interrelated fields of textile research. These instruments have included a number of devices for measuring the stress-strain behavior of fibers, rovings, yarns, and fabrics, and for estimating the evenness of yarns and other fiber assemblies. Such tools have afforded workers a new approach to many very old problems of fiber behavior in various textile processing operations. Drafting and spinning have received renewed attention both from a theoretical point of view and from the very practical aspects of mill operation. The possibility of making precise measurements of the physical properties of various fiber assemblies has encouraged a considerable amount of investigation into the interrelationship of the properties of such structures. This work has contributed to our understanding of the principles involved in designing and using various textile structures. Many papers based upon information available from instruments of this sort are included in the *Review* under appropriate subject headings, particularly those in Section **X**.

The application of other new machines and processes is apparent in many sections of the *Review*. In instances where all papers describing the utilization of a new technique do not fall under the same subject heading, cross-references to the other applications have been provided.

References in the 1952 *Review* point up the pressing demand for technological information useful in the processing of synthetic fibers and blends. This need is strikingly illustrated in the sections covering the development of manufacturing and dyeing processes, but its effects can also be seen in the directions which some fundamental work is taking. A great deal of attention has been directed to the preparation of blends and their processing on various drawing and spinning systems. The considerable activity over the last few years in the field of dyeing synthetic fibers has continued, and the dyeing of blends has become an important aspect of this work.

Cellulose Fibers

Cellulose is an important chemical raw material as well as the primary constituent of the most widely used class of textile fibers. Its chemical properties have consequently received and continue to receive considerable attention. The conversion of cellulose by xanthation and acetylation into forms suitable for fiber spinning and the behavior of the xanthate and acetate derivatives in solution have been the subjects of many research papers during the past year. The preparation and properties of carboxymethylcellulose have also been actively investigated, and the applications of this material have increased largely because of its usefulness as a builder in detergent compositions.

The susceptibility of cellulose fibers to oxidation during wet finishing, dyeing, and other operations, and the economic importance of the resulting degradation have continued to stimulate interest in the detection of oxidized cellulose and the investigation of its properties. Hydrolysis, the chief reaction other than oxidation responsible for the deterioration of cellulose, has also received attention, especially by workers concerned with the enzymic hydrolysis of cellulose by microorganisms. Work in this field is reported in papers cited in Section **VII** as well as in the appropriate subsections of Section **II**.

The physical properties of cellulosic fibers have not been neglected. The application of electron microscopy to the study of the fine structure of fibers has already been indicated. The correlation of the contributions of this technique with those of optical microscopy, x-ray diffraction, and other methods has considerably advanced our comprehension of fiber structure. This increasing understanding will affect the interpretation of studies of the accessibility of the cellulose to various reagents, the reactivity of pulps, the absorption and swelling behavior of cellulose, and its mechanical properties, which continue to be active subjects for research.

Protein Fibers

Investigation of the structure and properties of protein fibers is of wide biological importance, and the textile protein fibers are only a part of this problem. A grasp of its more general aspects is very useful in following developments in the morphology, fine structure, and x-ray structure of wool and silk. These interrelationships are also important in the

work which has been reported on the chemical structure and biosynthesis of these fibers.

In research on the mechanical properties of protein fibers, emphasis has been placed on studies of the elastic modulus and the use of chemical reagents and resins for modifying physical behavior. The reaction kinetics involved in stress relaxation of wool when various stress-supporting bonds are chemically broken has also been studied.

The detection of wool damage, its effect on mechanical properties, and its prevention have been reported in a number of papers referred to in Sections **III** and **VII**. The composition of wool wax and the structure of some of its components have received some attention because of the economic desirability of finding uses for this by-product. There appears to have been little activity in the field of regenerated protein fibers.

Synthetic Fibers and Other High Polymers

The synthetic fibers are a special group of materials in the large and growing class of man-made high polymers. The published research on synthetic fibers in 1952 has stressed the problems involved in relating fiber structure to mechanical properties and to fiber behavior in textile finishing and dyeing. The aspects of structure which have been considered include chemical composition, crystallinity, and orientation. In addition to these structural parameters, the effect of fiber morphology on mechanical behavior should receive more attention than the published literature indicates. All of these problems are of general interest in the high-polymer field, and Parts ***A***, ***B***, and ***D*** of Section **V** contain papers concerned with more general aspects of the relations between structure and properties. Studies of viscoelastic behavior, solid-state rheology, relation of static to dynamic properties, absorption, and swelling are included. Reports concerned more directly with individual synthetic fibers are cited in the sections on the particular fiber.

A large number of papers on the production and properties of polyvinylalcohol fibers has appeared in Japanese journals, but it is not clear whether these fibers have become commercially important in Japan.

Molecular-Weight Determination

The published literature indicates that viscosity continues to be the most widely used method for estimating the molecular weight of high polymers. Recent work on this technique has been concerned primarily with the non-Newtonian flow characteristics of high-polymer solutions. Approaches to this problem, for the most part, have attempted to extend the application of Newtonian conditions by perturbation methods. Osmometry, light scattering, and ultracentrifugation are chief among the other techniques which have been used for determining the molecular weight of high polymers. Advances in the principle and application of the light-scattering method during 1952 indicate that this relatively new technique may not yet have reached its fullest development.

The principles of molecular-weight determination by the methods mentioned above involve many aspects of the behavior of high-polymer molecules in solution, and papers discussing some of these aspects are among the references in Section **VC**.

Test Methods and Apparatus

Each area of textile research develops test methods and apparatus, and descriptions have been published of many specialized techniques for analyzing cellulose, cellulose derivatives, and surface-active agents, for controlling vat dye baths, for matching colors and testing their fastness, for measuring the mechanical properties and evenness of fiber assemblies, for evaluating detergency, and for many other purposes. These are cited under appropriate subject headings throughout the *Review*. A number of less specialized tests have been grouped in Section **IX**. There are a large number of papers on the geometrical and physical properties of single fibers and fiber assemblies, and on new methods for determining fiber fineness and staple-length distributions. Procedures for studying the mechanical properties of slivers, tops, and rovings and for determining the wear and abrasion-resistance of fabrics have also been described.

The introduction of new fibers and their common use in blends have made necessary the development of new schemes for analyzing mixtures of fibers. A number of new procedures for determining various finishing agents on fibers have been reported.

Fiber-Yarn-Fabric Relationships

The engineering approach to studies of the relationships among the properties of fibers, yarns, and fabrics has been greatly advanced since the war, and

is now of assistance to an increasing number of workers in this very complex field. Further work will have to be done, however, before satisfactory predictions of the behavior of yarns and fabrics can be made from the properties of their constituents. Interfiber friction, its effect on drawing and spinning, and the role of twist in determining the elasticity and strength of yarns have been studied in many laboratories. Instruments for determining the regularity of yarns and loose fiber assemblies have contributed to the understanding of the behavior of fibers during processing, and are now becoming useful tools in manufacturing control.

Textile Manufacturing

Although developments in manufacturing processes for natural fibers have not been neglected in the literature for 1952, the synthetic fibers have received a larger share of attention than their relative use would indicate. This is perhaps a natural consequence of the introduction of such a wide variety of new fibers. No novel machinery has been developed for the mechanical processing of synthetics, but many papers have described the adaptation of existing manufacturing systems for handling synthetics and blends of synthetics with natural and regenerated fibers. Static electricity presents a major difficulty in working with the synthetic fibers, and published reports indicate that considerable fundamental and applied research on this problem is in progress.

Numerous discussions of various phases of spinning and weaving have appeared. The design of more effective guides and rollers for drawing, the forces involved in spinning and the aerodynamics of the yarn balloon, the effect of warp tension in weaving, and the analysis of shuttle trajectories are some of the problems which have been examined in detail.

Dyeing and Finishing

Problems encountered with synthetic fibers are the major concern of dyers. A number of processes, some involving new types of machinery, have been introduced since the war. Some have been designed for hydrophobic fibers; others were advances in dyeing procedures for established fibers. Development of these techniques continued during 1952. Further work on the cuprous ion process for dyeing acrylic fibers and on various methods for high-pressure and high-temperature dyeing has been presented. Theoretical investigations of the dyeing process, the behavior of dyes in solution, and the mechanism of dye-fiber interaction have received attention. Techniques for evaluating and matching colors and for determining the fastness properties of dyed materials have also been described.

The area of finishing in which publication has been most active is that concerned with stabilizing and crushproofing cellulosic fabrics with synthetic resins. There have also been some papers devoted to milling, shrinkproofing wool, flameproofing, and other finishing processes.

Bibliography

I. PAPERS OF GENERAL INTEREST

1. Anon., **Textile terms and definitions,** *J. Text. Inst.* **43,** S1–25 (1952).
2. Dillon, J. H., **The textile rainbow,** *Am. Dyestuff Reptr.* **41,** 65–8 (1952).
3. Fox, K. R., **Technical problems of the textile industry,** TEXTILE RESEARCH JOURNAL **22,** 60–4 (1952).
4. Gantz, G. M., **Fibers, fabrics, and finishes of the future,** *Am. Dyestuff Reptr.* **41,** P447–52 (1952).
5. Goldberg, J. B., **New textile fibres, fabrics and finishes,** *Can. Text. J.* **69,** No. 5, 59–62 (1952).
6. Goldberg, J. B., **Textile research achievements in 1952,** *Textile Bull.* **79,** No. 1, 49–50, 52, 54–6, 58 (1953); *Textile Age* **17,** No. 2, 58–63, 78–80 (1953).
7. Hall, W. J., and Hooper, C. J. W. (Editors), **"Review of Textile Progress, Vol. 3, 1951,"** Manchester, England, The Textile Institute, and Bradford, England, The Society of Dyers and Colourists, 1952, 590 pp.
8. International Union of Pure and Applied Chemistry (Committee on Nomenclature), **Report on nomenclature in the field of macromolecules,** *J. Polymer Sci.* **8,** 257–77 (1952).
9. Kennedy, S. J., **Use of fibres in military applications,** *Can. Text. J.* **69,** No. 13, 57–62 (1952).
10. Lockspeiser, B., **Science and the textile industry,** *J. Text. Inst.* **43,** P893–902 (1952).
11. Newton, R. B., **Research pays off,** TEXTILE RESEARCH JOURNAL **22,** 65–9 (1952).
12. Oversby, R. G., **Impressions of textile technical training, research and production in the textile industry of the United States of America,** *J. Text. Inst.* **43,** P309–21 (1952).
13. Steele, R., and Messler, C. (editors), **Review of textile research and development during 1951,** TEXTILE RESEARCH JOURNAL **22** (May 1952) (entire issue).
14. Waterman, A. T., **Building our national scientific capital to yield applied research interest for industry in the future,** TEXTILE RESEARCH JOURNAL **22,** 69–74 (1952).

PAPERS OF GENERAL INTEREST

15. Wells, R. D., **Position of the textile industry in relation to research and development,** TEXTILE RESEARCH JOURNAL **22**, 53–60 (1952).

II. CELLULOSE FIBERS

A. Chemistry of Cellulose

1. Chemical Structure of Cellulose

16. Almin, K. E., **The reaction between cellulose and heavy water,** *Svensk Papperstidn.* **55**, 767–70 (1952) (in English).
17. Ant-Wuorinen, O., **The reactivity of the carboxyl groups of cellulose,** *Paper and Timber* (Finland) **34**, 195–201 (1952) (in English) (*Bull. Inst. Paper Chem.* **22**, 816 (1952)).
18. Asunmaa, S., and Lange, P. W., **Distribution of the carboxyl groups in the cell wall of spruce and birch holocellulose and cotton,** *Svensk Papperstidn.* **55**, 217–23 (1952) (in English).
19. Barchewitz, P., Henry, L., and Chedin, J., **Some results concerning the infrared spectrography of cellulose and its derivatives,*** *J. chim. phys.* **48**, 590–3 (1951).
20. Bell, D. J., **The "Cross and Bevan" cellulose of *Posidonia australis*,** *J. Chem. Soc.* **1952**, 3649–50.
21. Chatterjee, H., **Iodoform reaction with jute cellulose,** *Current Sci.* (India) **21**, 22 (1952).
22. Edelmann, K., **The conductometric titration of carboxyl groups in cellulose,*** *Faserforsch. u. Textiltech.* **3**, 1–5 (1952).
23. Emery, C., and Cohen, W. E., **Chain-length distribution studies on nitrated wood and cotton celluloses,** *Australian J. Applied Sci.* **2**, 473–87 (1951).
24. Heuser, E., **The present status of the chemistry of cellulose,** *Tappi* **35**, 481–9 (1952).
25. Hirsch, P., **The behavior of membranes between electrolyte solutions: III: The dissociation of carboxyl groups in cellulose,** *Rec. trav. chim.* **71**, 525–44 (1952) (in English).
26. Kursanov, A. L., and Vyskrebentseva, E. I., **Change in the constitution of cotton fiber in relation to the synthesis of cellulose,*** *Biokhimiya* **17**, 480–7 (1952) (*Chem. Abstracts* **47**, 859b (1953)).
27. Pakshver, A. B., and Frolov, S. S., **Solubility of cellulose in ten percent solution of alkali,*** *Zhur. Priklad. Khim.* **23**, 530–5 (1950) (*Chem. Abstracts* **46**, 6826f (1952)).
28. Pearl, W. L., **The sorption and rate of sorption of the amylose fraction of starch by papermaking fibers,** *Tappi* **35**, 41–8 (1952).
29. Rånby, B. G., **Cellulose and muscle: The colloidal properties of cellulose micelles,** *Discussions Faraday Soc.* **1951**, No. 11, 158–64 + 4 plates.
30. Sharkov, V. I., and Sobetskiĭ, S. V., **Chemical composition of cellulose: VIII,*** *Zhur. Priklad. Khim.* **21**, 659–66 (1948) (*Chem. Abstracts* **46**, 251c (1952)).
31. Shirk, H. G., and Greathouse, G. A., **Infrared spectra of bacteriai cellulose,** *Anal. Chem.* **24**, 1774–5 (1952).
32. Sihtola, H., and Puustjärvi, V., **On the acidic character of cellulose: I,** *Suomen Kemistilehti* **B24**, 36–43 (1951) (in English).
33. Tarkow, H., and Stamm, A. J., **The reaction of formic acid with carbohydrates: I: The reaction of formic acid with sugars,** *J. Phys. Chem.* **56**, 262–6 (1952).
34. Tarkow, H., and Stamm, A. J., **The reaction of formic acid with carbohydrates: II: Polysaccharides: A new method for determining accessibility,** *J. Phys. Chem.* **56**, 266–71 (1952).

2. Reactions of Cellulose

(a) Oxidation and Decomposition

35. Araki, T., and Iida, H., **Thermal decomposition and oxidation of cellulose: I: Thermal decomposition,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 277–8 (1952) (*Chem. Abstracts* **46**, 9299f (1952)).
36. Araki, T., and Iida, H., **Thermal decomposition and oxidation of cellulose: II: Oxidation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 279–81 (1952) (*Chem. Abstracts* **46**, 9299g (1952)).
37. Blair, M. G., and Reeves, R. E., **Gluconic acid from hypoiodite-oxidized hydrocellulose,** *J. Am. Chem. Soc.* **74**, 2622–3 (1952).
38. Davidson, G. F., **The preparation of acidic oxycelluloses by the action of alkaline hypobromite on cotton cellulose,** *J. Text. Inst.* **43**, T291–8 (1952).
39. Hirsch, P., **The acid strength of glucuronic acid in comparison with that of oxycelluloses,** *Rec. trav. chim.* **71**, 999–1006 (1952) (in English).
40. Ivanov, V. I., Kaverzneva, E. D., and Kuznetsova, Z. I., **Primary reactions in the oxidation of cellulose by hydrogen peroxide,*** *Doklady Akad. Nauk S.S.S.R.* **86**, 301–4 (1952) (*J. Soc. Dyers and Colourists* **69**, 70 (1953)).
41. Kaverzneva, E. D., **Chemical changes of cellulose macromolecule under action of oxidizing agents: V: Proof of existence of α-hydroxymonoketone groups in oxycellulose,*** *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk* **1951**, 791–4 (*Chem. Abstracts* **46**, 5834d (1952)).
42. Kaverzneva, E. D., Ivanov, V. I., and Salova, A. S., **Chemical changes of cellulose macromolecule under action of oxidizing agents: VI: The presence in oxycelluloses of groups of carbonic esters and their effect on the determination of uronic carboxylic groups,*** *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk* **1952**, 185–9 (*Chem. Abstracts* **46**, 7323h (1952)).
43. Kaverzneva, E. D., Ivanov, V. I., and Salova, A. S., **Chemical changes of cellulose macromolecule under action of oxidizing agents: VII: Chemical transformations of cellulose during its oxidization by sodium hypochlorite,*** *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk* **1952**, 751–62 (*Chem. Abstracts* **47**, 859i (1953)).
44. Kaverzneva, E. D., and Salova, A. S., **Chemical changes of cellulose macromolecule under action of oxidizing agents: IV: Lactone links in the macromolecule of oxycellulose and their effect on determination of carbonyl groups by condensation with hydroxylamine,*** *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk* **1951**, 782–90 (*Chem. Abstracts* **46**, 5833g (1952)).
45. Kocher, F., **Determination of the threshold at which cellulose is attacked by acid solutions of sodium chlorite,*** *Bull. inst. text. France*, No. 31, 19–90; No. 32, 19–106 (1952).

* Throughout this list, an asterisk (*) following a title denotes that the title is a translation.

46. Lapèze, R. P., and Dardelet, S., **Attack on cellulose by means of sodium chlorite and chlorine dioxide at various pH values,*** *Ann. Inst. Polytechnique Grenoble*, Special Number, 23–35 (1952) (*Bull. Inst. Paper Chem.* **22**, 899 (1952)).

47. Meller, A., **Studies on modified cellulose: II: The hot alkali stability and acid hydrolytic resistance of modified cellulose,** *Tappi* **35**, 72–5 (1952).

48. Nabar, G. M., and Padmanabhan, C. V., **Studies in oxycellulose: III: Oxidation of cellulose with a mixture of nitrogen dioxide and oxygen,** *Proc. Indian Acad. Sci.* **32A**, 212–31 (1950).

49. Nabar, G. M., and Padmanabhan, C. V., **Studies in oxycellulose: IV: Chemical behavior of accelerated oxidation oxycelluloses,** *Proc. Indian Acad. Sci.* **32A**, 232–9 (1950).

50. Nagano, M., **Aging of alkali cellulose: III: Distribution of the polymerization degree of cellulose,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 271–4 (1949) (*Chem. Abstracts* **46**, 3757b (1952)).

51. Nagano, M., and Isobe, M., **Aging of alkali cellulose: I: Production of oxycellulose (a preliminary report),*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 165–8 (1949) (*Chem. Abstracts* **46**, 3757a (1952)).

52. Nagano, M., and Kato, T., **Aging of alkali cellulose: II: Oxycellulose by aging,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 211–15 (1949) (*Chem. Abstracts* **46**, 3757b (1952)).

53. Nagano, M., and Ochi, Y., **Aging of alkali cellulose: V: Effects of some metals on the degradation of cellulose,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 316–19 (1950) (*Chem. Abstracts* **46**, 6379g (1952)).

54. Tamaru, K., **Combustion process of cellulose,*** *J. Chem. Soc. Japan*, Pure Chem. Sect., **69**, 21–2 (1948) (*Chem. Abstracts* **46**, 8849e (1952)).

55. Tamaru, K., **Effects of inorganic substances on the carbonization and the combustion of cellulose,*** *J. Chem. Soc. Japan*, Pure Chem. Sect., **69**, 20–1 (1948) (*Chem. Abstracts* **46**, 8849d (1952)).

56. Zakharov, B. A., **The decomposition of cotton by heating in a high frequency electromagnetic field,*** *Doklady Akad. Nauk S.S.S.R.*, **81**, 417–19 (1951); *Faserforsch. u. Textiltech.* **3**, 154–5 (1952).

See also [17, 22, 25, 32, 225, 340, 953, 954, 957, 960, 966, 968, 970, 1049, 1050, 1148]

(*b*) *Hydrolysis and Alcoholysis*

57. Abadie, F. A., **Variations of the degree of polymerization of the α-cellulose residue in the course of the hydrolysis of materials containing cellulose,*** *Compt. rend.* **233**, 752–4 (1951).

58. Bauer, F. W., and Pacsu, E., **Cellulose studies: XVII: The heterogeneous acid degradation of cellulose,** TEXTILE RESEARCH JOURNAL **22**, 385–97 (1952).

59. Bauer, F. W., and Pacsu, E., **Cellulose studies: XVIII: The homogeneous degradation of cellulose in phosphoric acid,** TEXTILE RESEARCH JOURNAL **22**, 397–404 (1952).

60. Blair, M. G., **Alcoholysis of cellulose with 2-methoxyethanol,** *J. Am. Chem. Soc.* **74**, 3411–14 (1952).

61. Hartler, N., and Samuelson, O., **Degradation of cotton and wood pulp with ligninsulfonic acid and sulfite waste liquor,** *Svensk Papperstidn.* **55**, 851–62 (1952) (in English).

62. Matsuzaki, K., and Sobue, H., **Heterogeneous hydrolytic degradation of cellulose,** *Bull. Chem. Soc. Japan* **24**, 184–7 (1951) (in English).

63. Müller, O., and Dobberstein, H., **Investigation of the hydrolysis of beechwood by continuous conductance measurements,*** *Makromol. Chem.* **8**, 156–77 (1952).

64. Nakamura, S., and Ichino, K., **Hydrolysis and fermentation of fibers: VI: Hydrolysis of cellulose by concentrated hydrochloric acid (2),*** *J. Fermentation Technol.* (Japan) **26**, 151–3 (1948) (*Chem. Abstracts* **47**, 859h (1953)).

65. Norkrans, B., **Influence of cellulolytic enzymes from hymenomycetes on cellulose preparations of different crystallinity,** *Physiol. Plantarum* **3**, 75–87 (1950).

66. Reese, E. T., and Downing, M. H., **Activity of the *Aspergilli* on cellulose, cellulose derivatives, and wool,** *Mycologia* **43**, 16–28 (1951).

67. Rodet, P., **Contribution to the study of the degradation of cellulosic fibers in acidic medium,*** *Ann. chim.* **6**, 786–834 (1951).

68. Roseveare, W. E., **Characterization of celluloses by hydrolysis,** *Ind. Eng. Chem.* **44**, 168–72 (1952).

69. Spurlin, H. M., **The homogeneous degradation of cellulose,** TEXTILE RESEARCH JOURNAL **22**, 693 (1952) (Letter to the Editor).

70. Walseth, C. S., **The influence of the fine structure of cellulose on the action of cellulases,** *Tappi* **35**, 233–8 (1952) (*Bull. Inst. Paper Chem.* **22**, 738 (1952)).

71. Wolfrom, M. L., and Dacons, J. C., **The polymer-homologous series of oligosaccharides from cellulose,** *J. Am. Chem. Soc.* **74**, 5331–3 (1952).

(*c*) *Preparation and Properties of Cellulose Ethers*

(*1*) Carboxymethylation

72. Basu, S., and Das Gupta, P. C., **Studies on polyelectrolytes: I: Sodium carboxymethylcellulose,** *J. Colloid Sci.* **7**, 53–70 (1952).

73. Bouttemy, M., **Contribution to the study of carboxymethylcellulose: II: Analysis and degree of substitution,*** *Bull. soc. chim. France* **1952**, 343–4.

74. Daul, G. C., Reinhardt, R. M., and Reid, J. D., **Studies on the partial carboxymethylation of cotton,** TEXTILE RESEARCH JOURNAL **22**, 787–92 (1952).

75. Dyer, E., and Arnold, H. E., **Distribution of hydroxyl groups in carboxymethyl cellulose,** *J. Am. Chem. Soc.* **74**, 2677–9 (1952).

76. Kagawa, I., Katsuura, K., Saitō, A., and Fukuda, M., **High-molecular electrolytes: XX: Influence of neutralization reagent on the dissociation equilibrium of weak high-molecular electrolyte,*** *J. Chem. Soc. Japan*, Ind. Chem. Sect., **54**, 95–6 (1951) (*Chem. Abstracts* **47**, 9501 (1953)).

77. Kagawa, I., Katsuura, K., Saitō, A., and Fukuda, M., **High-molecular electrolytes: XXI: Determination of molecular weight of sodium celluloseglycolate by osmotic method,*** *J. Chem. Soc. Japan*, Ind. Chem. Sect., **54**, 97–9 (1951) (*Chem. Abstracts* **47**, 951a (1953)).

78. Katsuura, K., Saitō, A., and Kagawa, I., **High-molecular electrolytes: XIX: Preparation of carboxymethylcellulose,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 268–70 (1950) (*Chem. Abstracts* **46**, 6379h (1952)).

CELLULOSE FIBERS

79. Nodzu, R., Torigata, H., and Inokawa, S., **The colloidal behavior of high-molecular compounds from the standpoint of structural chemistry,*** *J. Chem. Soc. Japan,* Pure Chem. Sect., **72**, 1058–61 (1951) (*Chem. Abstracts* **46**, 9380a (1952)).
80. Pacault, A., Bouttemy, M., and Tanaevsky, O., **Contribution to the study of carboxymethylcellulose: III: Lowering of the degree of substitution and chain length,*** *Bull. soc. chim. France* **1952**, 345–7.
81. Pals, D. T. F., and Hermans, J. J., **Sodium salts of pectin and of carboxymethylcellulose in aqueous sodium chloride: I: Viscosities,** *Rec. trav. chim.* **71**, 433–57 (1952) (in English).
82. Pals, D. T. F., and Hermans, J. J., **Sodium salts of pectin and of carboxymethylcellulose in aqueous sodium chloride: II: Osmotic pressures,** *Rec. trav. chim.* **71**, 458–67 (1952) (in English).
83. Pals, D. T. F., and Hermans, J. J., **Sodium salts of pectin and of carboxymethylcellulose in aqueous sodium chloride: III: Potentiometric titration,** *Rec. trav. chim.* **71**, 513–20 (1952) (in English).
84. Timell, T. E., **Studies on carboxymethylcellulose: I: A method for estimating the distribution of the substituents in partially substituted carboxymethylcelluloses,** *Svensk Papperstidn.* **55**, 649–60 (1952) (in English).
85. Timell, T. E., and Spurlin, H. M., **Studies on carboxymethylcelluloses: II: The distribution of the substituents in partially substituted carboxymethylcelluloses,** *Svensk Papperstidn.* **55**, 700–8 (1952) (in English).

See also [172, 1018, 1890]

(2) Methylation and Ethylation

86. Dhingra, D. R., and Mithel, B. B., **Etherification of cellulose: I,** *J. Indian Chem. Soc., Ind. & News Ed.* **14**, 97–103 (1951).
87. Glikman, S. A., and Efremova, O. G., **Effect of metal ions on the elasto-plastic characteristics of ethylcellulose,*** *Doklady Akad. Nauk S.S.S.R.* **81**, 1089–92 (1951) (*Chem. Abstracts* **46**, 4324f (1952)).
88. Haas, H. C., Farney, L., and Valle, C., Jr., **Some properties of ethyl cellulose films,** *J. Colloid Sci.* **7**, 584–99 (1952).
89. Inokawa, S., **Colloidal behaviors of high-molecular compounds from the standpoint of structural chemistry: II: Action of phenol and aniline on the colloidal behavior of methylcellulose in aqueous solution,*** *J. Chem. Soc. Japan,* Pure Chem. Sect., **73**, 334–7 (1952) (*Chem. Abstracts* **47**, 862c (1953)).
90. Noguchi, T., and Kakurai, T., **Ethylcellulose: I: Ethylation of cellulose treated with 50 percent sodium hydroxide,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 16–19 (1950) (*Chem. Abstracts* **46**, 4790b (1952)).
91. Noguchi, T., and Kakurai, T., **Ethylcellulose: II: Effect of lowering the water content of alkali cellulose on ethylation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 100–2 (1950) (*Chem. Abstracts* **46**, 4790c (1952)).
92. Noguchi, T., and Kakurai, T., **Ethylcellulose: III: Effect of the sodium hydroxide content of alkali cellulose on ethylation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 211–13 (1950) (*Chem. Abstracts* **46**, 4790d (1952)).
93. Noguchi, T., and Kakurai, T., **Ethylcellulose: IV: Effect of reaction time on ethylation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 267–8 (1950) (*Chem. Abstracts* **46**, 4790d (1952)).
94. Noguchi, T., and Kakurai, T., **Ethylcellulose: V: Production of ethylcellulose soluble in organic solvents,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 607–9 (1950) (*Chem. Abstracts* **46**, 4790e (1952)).
95. Reeves, R. E., Barrett, B. J., and Mazzeno, L. W., Jr., **The heterogeneous hydrolysis of highly methylated cotton cellulose,** *J. Am. Chem. Soc.* **74**, 4491–4 (1952).
96. Rydholm, S., **Etherification of cellulose: II: Reactivity of sodium cupricellulose,** *Svensk Papperstidn.* **55**, 661–4 (1952) (in English).
97. Stawitz, J., **Colloidal-chemical properties of water soluble methyl celluloses,*** *Melliand Textilber.* **33**, 620–3, 737–8 (1952).
98. Suda, T., **Stretching of cellulose derivative films: V: Ethylcellulose films,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 143–6 (1952) (*Chem. Abstracts* **46**, 9840e (1952)).

See also [171]

(3) Miscellaneous

99. Basu, S., and Choudhury, D. K. R., **Deformation of cellulose chain in cellulose triphenylmethyl ether,** *J. Sci. Ind. Research* (India) **11B**, 96–101 (1952).
100. Basu, S., and Roy, H. B., **Viscometric and osmometric determination of the molecular weights of benzylcellulose,** *J. Sci. Ind. Research* (India) **11B**, 94–6 (1952).
101. Fournier, P. L.-E., **Preparation and properties of hydroxyethyl ethers of cellulose and their derivatives,*** *Ann. chim.* **7**, 75–127 (1952).
102. Jullander, I., **Physico-chemical properties of ethylhydroxyethyl cellulose,** *Svensk Papperstidn.* **55**, 197–211 (1952) (in English).
103. Schuyten, H. A., Weaver, J. W., Frick, J. G., Jr., and Reid, J. D., **Formation of cellulose ethers in water-repellency treatment of cotton with stearamidomethylpyridinium chloride,** TEXTILE RESEARCH JOURNAL **22**, 424–32 (1952).
104. Suda, T., **Stretching of cellulose derivative films: VI: Benzylcellulose films,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 146–9 (1952) (*Chem. Abstracts* **46**, 9840f (1952)).
105. Ushakov, S. N., and Klimova, O. M., **Hydroxyethyl allyl ethers of cellulose and their copolymerization with sulfur dioxide,*** *Zhur. Priklad. Khim.* **25**, 46–56, 191–6 (1952) (*Chem. Abstracts* **46**, 5837a, 6826b (1952)).

(d) Preparation and Properties of Cellulose Esters

(1) Acetylation

106. Abribat, M., and Pouradier, J., **Effect of the spreading solvent on the unimolecular surface films of cellulose acetate,*** *Compt. rend.* **233**, 1606–8 (1951).
107. Araki, T., **Studies on cellulose acetate: III: Combination of sulfuric acid during the acetylation of cellulose and the mechanism of acetylation,** TEXTILE RESEARCH JOURNAL **22**, 630–6 (1952).
108. Asada, K., **Manufacture of acetylcellulose: IX: Acetone-soluble fibrous acetylcellulose,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 500–2 (1951) (*Chem. Abstracts* **46**, 6391c (1952)).

109. Asada, K., **Manufacture of acetylcellulose: X: Relation between the acetic value and quantity of acetic anhydride at the equilibrium point of fibrous acetylation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 134–7 (1952) (*Chem. Abstracts* **46**, 9300i (1952)).

110. Bazhenov, I. M., and Vol'kenshtein, M. V., **Optical activity of triacetylcellulose,*** *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk* **1952**, 334–43 (*Chem. Abstracts* **46**, 9381i (1952)).

111. Cooper, A. S., Voorhies, S. T., Jr., Buras, E. M., Jr., and Goldthwait, C. F., **Partial acetylation of cotton,** *Textile Inds.* **116**, No. 1, 97–102, 194–5 (1952).

112. Dervichian, D. G., and Magnant, C., **Different phase equilibria in cellulose acetate solutions,*** *Rec. trav. chim.* **71**, 80–7 (1952) (in French).

113. Freiman, A. A., **The aging of triacetate films,*** *Zhur. Priklad. Khim.* **24**, 490–4 (1951) (*Chem. Abstracts* **46**, 9840a (1952)).

114. Freiman, A. A., Bartashev, V. A., Shagalova, L. I., Ganneman, V. V., Marova, G. P., and Ovchinnikova, E. L., **Stabilization of cellulose triacetate films against thermal oxidative degradations,*** *Zhur. Priklad. Khim.* **25**, 626–33 (1952) (*J. Soc. Dyers and Colourists* **68**, 481 (1952)).

115. Honold, E., Poynot, J. M., and Cucullu, A. F., **Heat-resistance of partially acetylated cotton fabrics,** TEXTILE RESEARCH JOURNAL **22**, 25–9 (1952).

116. Kido, I., and Kitajima, H., **Vapor-phase acetylation of refined linters by acetic anhydride,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 228–31 (1952) (*Chem. Abstracts* **46**, 9301a (1952)).

117. Kozlov, P. V., and Sherman, F. S., **Solubility of acetylcellulose in acetone,*** *Zhur. Priklad. Khim.* **25**, 384–91 (1952) (*Chem. Abstracts* **46**, 7325g (1952)).

118. Malm, C. J., Barkey, K. T., May, D. C., and Lefferts, E. B., **Treatment of cellulose prior to acetylation,** *Ind. Eng. Chem.* **44**, 2904–9 (1952).

119. Malm, C. J., Tanghe, L. J., Laird, B. C., and Smith, G. D., **Re-esterification during the hydrolysis of cellulose acetate,** *J. Am. Chem. Soc.* **74**, 4105–7 (1952).

120. Mayrargue, C., and Pâris, R. A., **Relation between the tinctorial affinity and the degree of swelling of progressively acetylated cellulose,*** *Compt. rend.* **234**, 2452–4 (1952).

121. Pakshver, A. B., and Dolinin, R. I., **Solutions of acetylcellulose,*** *Zhur. Priklad. Khim.* **23**, 775–84 (1950) (*Chem. Abstracts* **46**, 6379a (1952)).

122. Pakshver, A. B., and Kopylova, G. K., **Solutions of acetylcellulose with different acetyl numbers,*** *Zhur. Priklad. Khim.* **24**, 1052–7 (1951) (*Chem. Abstracts* **46**, 4221e (1952)).

123. Ruyssen, R., and Frank, S., **The determination of the molecular weight of cellulose diacetate by the surface-film method,*** *Ind. chim. belge* **16**, 389–90 (1951) (*Chem. Abstracts* **46**, 3369b (1952)).

124. Sakurada, I., Sakaguchi, Y., and Suzue, K., **Preparation of acetate rayon by the acetylation of viscose rayon with acetic anhydride vapor: III: Secondary pretreatment with acetic acid,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 138–40 (1952) (*Chem. Abstracts* **46**, 8859i (1952)).

125. Sakurada, I., Sakaguchi, Y., and Suzue, K., **Preparation of acetate rayon by the acetylation of viscose rayon with acetic anhydride vapor: IV: Secondary pretreatment with benzene or ethylene dichloride,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 140–2 (1952) (*Chem. Abstracts* **46**, 8860a (1952)).

126. Sherman, F. S., and Gol'dman, I. O., **Heterogeneous hydrolysis of triacetylcellulose,*** *Zhur. Priklad. Khim.* **25**, 84–9 (1952) (*Chem. Abstracts* **46**, 5836c (1952)).

127. Suda, T., **Stretching of cellulose derivative films: IX: Fractionated cellulose acetate films,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 272–6 (1952) (*Chem. Abstracts* **46**, 9840h (1952)).

128. Sumida, T., **Effect of stretching of cellulose acetate films on the heat softening process,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 549–52 (1951) (*Chem. Abstracts* **46**, 4237b (1952)).

129. Taniguchi, M., and Hosono, M., **Acetylation of cellulose in the vapor phase: I: Preparation of triacetylcellulose,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 206–9 (1950) (*Chem. Abstracts* **46**, 5315g (1952)).

130. Taniguchi, M., and Hosono, M., **Acetylation of cellulose in the vapor phase: II: Hydrolysis of acetylcellulose by moisture in air,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 209–11 (1950) (*Chem. Abstracts* **46**, 5315h (1952)).

131. Treiber, E., and Lang, W., **The light absorption of cellulose derivatives: II: The ultraviolet absorption spectrum of cellulose acetate and cellulose nitrate,*** *Melliand Textilber.* **33**, 1021–4 (1952).

See also [168]

(2) Miscellaneous

132. Berlin, A. A., and Makarova, T. A., **Chemistry and technology of synthetic high polymers: II: Preparation and polymerization of acetomethacrylic esters of cellulose,*** *Zhur. Obshchei Khim.* **21**, 1267–73 (1951) (*Chem. Abstracts* **46**, 1996c (1952)).

133. Chédin, J., **Some points of view on the nitration of cellulose fibers: Accessibility of the fiber for nitrating agents,*** *Kolloid-Z.* **125**, 65–72 (1952).

134. Chédin, J., and Tribot, A., **Different techniques used in nitrating cellulosic fibers,*** *Bull. assoc. tech. ind. papetière* **5**, 435–43 (1951) (*Chem. Abstracts* **46**, 3757h (1952)).

135. Chédin, J., and Tribot, A., **Nitration of cellulose with nitric acid-acetic anhydride mixture or with acetyl nitrate,*** *Mém. services chim. état* (Paris) **36**, No. 1, 31–42 (1951) (*Chem. Abstracts* **46**, 11673e (1952)).

136. Guthrie, J. D., **Ion exchange cottons,** *Ind. Eng. Chem.* **44**, 2187–9 (1952).

137. Mandelkern, L., and Flory, P. J., **Molecular dimensions of cellulose triesters,** *J. Am. Chem. Soc.* **74**, 2517–22 (1952).

138. Meissner, H. P., and Byrne, J., **Bonding of thin films,** *J. Applied Phys.* **23**, 1170–3 (1952).

139. Montenegro, D., **Stabilization of nitrocellulose,*** *Engenharia e quím.* (Rio de Janeiro) **3**, 197–8 (1951) (*Chem. Abstracts* **46**, 10613h (1952)).

140. Nicolas, L., **Influence of the method of nitrating cellulose on the degree of polymerization of nitrocellulose,*** *Bull. assoc. tech. ind. papetière* **5**, 427–35 (1951) (*Chem. Abstracts* **46**, 3758a (1952)).

141. Rath, H., Meyer, H., and Bierling, H., **The action of ketenes (carbon suboxide and carbomethylene) on protein, polyamide, and cellulosic fibers,*** *Melliand Textilber.* **33**, 427–8 (1952).

142. Rigamonti, R., and Riccio, V., **Esters of dibasic organic acids with cellulose,*** *Ann. chim.* (Rome) **42**, 283–92 (1952) (*Chem. Abstracts* **46**, 11672e (1952)).

CELLULOSE FIBERS

143. Scherer, P. C., and Lou, L.-H., **Fractionation of cellulose nitrate: Effect of degree of substitution,** *Rayon and Synthetic Texts.* **32**, No. 5, 41–4 (1952).
144. Schneebeli, P., **Study of the addition of phenylisocyanate to the hydroxyl groups of cellulose,*** *Compt. rend.* **234**, 738–40 (1952).
145. Segall, G. H., and Purves, C. B., **The action of hydroxylamine, its *O*-methyl ether, and their hydrochlorides on cellulose trinitrate in pyridine,** *Can. J. Chem.* **30**, 860–71 (1952).
146. Smith, R. D., **Pyrolysis of dissolved nitrocellulose,** *Nature* **170**, 844–5 (1952) (Letter to the Editor).
147. Watanabe, S., **Nitrocellulose: XXXI: Nitration of powdered cellulose,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 141–3 (1949) (*Chem. Abstracts* **46**, 3269b (1952)).
148. Watanabe, S., **Nitrocellulose: XXXII: Stabilization of nitrohemicelluloses,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 143–6 (1949) (*Chem. Abstracts* **46**, 3269c (1952)).

(e) *Reaction with Alkali*

149. Ashar, K. G., **Fixation of potassium and lithium hydroxide by cellulose,*** *J. chim. phys.* **48**, 583–6 (1951).
150. Bartunek, R., **Potassium hydroxide-cellulose and potassium cellulose xanthate,*** *Das Papier* **6**, 356–8 (1952).
151. Champetier, G., Legrand, C., and Gouabaud, G., **Effect of alcoholic and aqueous-alcoholic solutions of sodium hydroxide on cellulose,*** *Compt. rend.* **233**, 1602–4 (1951).
152. Hess, K., and Grotjahn, H., **The action of carbon oxysulfide on alkali cellulose,*** *Z. Elektrochem.* **56**, 58–61 (1952).
153. Kobayashi, H., and Tanaawa, H., **Depolymerization of alkali cellulose by aging,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 205–8 (1949) (*Chem. Abstracts* **46**, 4222a (1952)).
154. Legrand, C., and Grund, A., **Formation of alkali celluloses in aqueous alcoholic medium,*** *J. Polymer Sci.* **9**, 527–30 (1952).
155. Petitpas, G., and Petitpas, T., **Reaction of the cellulose with diamines,*** *Mém. services chim. état* (Paris) **36**, No. 1, 25–9 (1951) (*Chem. Abstracts* **46**, 11673a (1952)).
156. Rânby, B. G., **The mercerization of cellulose: I: Thermodynamic discussion,** *Acta Chem. Scand.* **6**, 101–15 (1952) (in English).
157. Rânby, B. G., **The mercerization of cellulose: II: A phase transition study with x-ray diffraction,** *Acta Chem. Scand.* **6**, 116–27 (1952) (in English).
158. Rânby, B. G., **The mercerization of cellulose: III: A phase transition study with electron diffraction,** *Acta Chem. Scand.* **6**, 128–38 (1952) (in English).

See also [345]

(f) *Miscellaneous*

159. Arkhipov, M. I., and Bykov, A. N., **Differences of the reactivities of some polyhydroxy compounds in cuprammoniacal solution and their dependence on the ammonia concentration,*** *Zhur. Priklad. Khim.* **24**, 102–12 (1951) (*Chem. Abstracts* **47**, 29c (1953)).
160. Nickerson, R. F., **The reaction of cellulose with formaldehyde,** TEXTILE RESEARCH JOURNAL **22**, 554–5 (1952) (Letter to the Editor).
161. Noguchi, T., **Xanthation in the viscose process: VII: Trityl etherification of primary alcohol group at C-6 in the cellulose-glucose unit,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 314–16 (1950) (*Chem. Abstracts* **46**, 5835d (1952)).
162. Shtitevskiĭ, V. V., Obolonskaya, N. A., and Nikitin, N. I., **Vinylation of cellulose,*** *Zhur. Priklad. Khim.* **24**, 1045–51 (1951) (*Chem. Abstracts* **46**, 4221c (1952)).
163. Wagner, R. E., and Pacsu, E., **Cellulose studies: XVI: The reaction of cellulose with formaldehyde,** TEXTILE RESEARCH JOURNAL **22**, 12–20 (1952).
164. Warren, J., Reid, J. D., and Hamalainen, C., **Action of cyanuric chloride on cotton cellulose,** TEXTILE RESEARCH JOURNAL **22**, 584–90 (1952).

See also [1973]

3. *Analysis of Cellulose and Cellulose Derivatives*

165. Bennett, E., **Modification of Norman-Jenkins method for determination of cellulose,** *Anal. Chem.* **24**, 1510–11 (1952).
166. Broniatowski, A., **Quantitative determination of phosphorus pentoxide retained by impregnated wood fibers,*** *Svensk Papperstidn.* **55**, 313–15 (1952) (in German).
167. Courtecuisse, S., **Determination of ash content of cellulosic pulp,*** *Mém. services chim. état* (Paris) **36**, No. 1, 21–3 (1951) (*Chem. Abstracts* **46**, 9474g (1952)).
168. Genung, L. B., *et al.*, **Interlaboratory study on determination of acetyl in cellulose acetate,** *Anal. Chem.* **24**, 400–3 (1952).
169. Loewus, F. A. **Improvement in anthrone method for determination of carbohydrates,** *Anal. Chem.* **24**, 219 (1952).
170. Pelgroms, I. D., and Villers, L., **Improvement in the method for determining the copper number of pulps,*** *Papeterie* **74**, 87, 89, 91 (1952) (*Bull. Inst. Paper Chem.* **22**, 570 (1952)).
171. Redfarn, C. A., and Newton, D. R., **A note on ethoxy determination of ethyl cellulose,** *Chemistry & Industry* **1952**, 404 (*cf.* McCorkindale, W., and Syme, A. C., **The Zeisel method for the determination of alkoxy groups,** *ibid.*, p. 758).
172. Terayama, H., **Method of colloid titration (a new titration between polymer ions),** *J. Polymer Sci.* **8**, 243–53 (1952).

See also [1146, 1920, 1925]

B. *Fine Structure of Cellulose*

173. Abadie, F. A., **Similarity to α-cellulose of the cellulose fraction obtained by nitration, solution in acetone, and precipitation with water,*** *Compt. rend.* **233**, 629–31 (1951).
174. Drummond, D. G., **The products of fragmentation of textile fibres, as seen in the electron microscope,** *Shirley Inst. Mem.* **26**, 53–8 (1952).
175. Emerton, H. W., and Wrist, P. E., **Electron-microscopy of degraded cellulose fibres (with comments by J. Sikorski and H. J. Woods),** *J. Text. Inst.* **43**, T563–4 (1952) (Letter to the Editor).

176. Frey-Wyssling, A., and Mühlethaler, K., **The fine structure of cellulose,*** *Fortschr. Chem. org. Naturstoffe* **8**, 1–27 (1951) (*Bull. Inst. Paper Chem.* **22**, 403 (1952)).

177. Fröhlich, H. G., **The determination of the density of cellulose fibers by the suspension method,*** *Z. ges. Textil-Ind.* **54**, 337–9 (1952).

178. Furuya, H., and Yurugi, T., **Fundamental studies on the estimation of the quality of rayon pulp: I: Changes of the fine structure by mercerization,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 268–70 (1949) (*Chem. Abstracts* **46**, 4222f (1952)).

179. Hanle, W., and Scherer, H., **Dichroism of stretched films,*** *Z. Naturforsch.* **6a**, 437–9 (1951).

180. Heikens, D., Hermans, P. H., and Weidinger, A., **Occurrence of small-angle x-ray diffraction maxima in some artificial cellulose fibres,** *Nature* **170**, 369–70 (1952) (Letter to the Editor).

181. Hermans, P. H., **The density of cellulosic fibers,*** *Industrie textile* **69**, 19–25, 79–81 (1952) (*Chem. Abstracts* **46**, 6825a (1952)).

182. Hermans, P. H., and Heikens, D., **Orientation in cellulose fibers as derived from measurements of dichroism of dyed fibers,** *Rec. trav. chim.* **71**, 49–55 (1952) (in English).

183. Hock, C. W., **The fibrillate structure of natural cellulose,** *J. Polymer Sci.* **8**, 425–34 (1952).

184. Iwanow, N., and Meybeck, J., **New technique for the study of the fine structure of viscose fibers,*** *Bull. inst. text. France*, No. 35, 51–73 + 10 plates (1952).

185. Janeschitz-Kriegl, H., Kratky, O., and Porod, G., **X-ray small-angle measurements on porous hydrated cellulose fibers,*** *Z. Elektrochem.* **56**, 146–54 (1952).

186. Kast, W., **New insight in the deformation process in cellulose gels through "complete" x-ray orientation measurements,*** *Kolloid-Z.* **125**, 45–51 (1952).

187. Kast, W., and Schwarz, R., **The uptake of water in lattice regions of cellulose II (hydrate cellulose),*** *Z. Elektrochem.* **56**, 228–33 (1952).

188. Kaushal, R., Walker, T. K., and Drummond, D. G., **Observations on the formation and structure of bacterial cellulose,** *Biochem. J.* **50**, 128–32 + 3 figures (1951).

189. Kratky, O., Porod, G., and Treiber, E., **Recent experiments and concepts regarding the mechanism of deformation of fibers,*** *Z. Elektrochem.* **55**, 481–90 (1951).

190. Kratky, O., and Treiber, E., **The water-induced lattice broadening of cellulose II,*** *Z. Elektrochem.* **55**, 716–17 (1951).

191. Legrand, C., **Modification of certain polymorphic forms of cellulose at high temperatures,*** *Compt. rend.* **233**, 407–9 (1951).

192. Legrand, C., **The space group of cellulose,*** *Acta Cryst.* **5**, 800–2 (1952) (in French).

193. Mahl, H., **Electron microscope studies on textile fibers,*** *Z. wiss. Mikroskop.* **60**, 372–80 (1952) (*Reyon Zellwolle u. Chemiefasern* **30**, 673 (1952)).

194. Makowska, J., **Analysis of the method of Hermans for determining the orientation of crystallites in cellulose fibers from Roentgen diagrams,*** *Prace Głównego Inst. Włókiennictwa*, No. 5, 91–6 (1952) (*Faserforsch. u. Textiltech.* **3**, 510 (1952)).

195. McDonald, T. R. R., and Beevers, C. A., **The crystal and molecular structure of α-glucose,** *Acta Cryst.* **5**, 654–9 (1952).

196. Meos, A. I., Vishniakova, M. N., Meos, E. A., and Bersenev, V. P., **Structure and properties of fibers,*** *Tekstil. Prom.* **9**, No. 1, 8–10 (1949) (*J. Text. Inst.* **43**, A327 (1952)).

197. Meyer, K. H., **Constitution and texture of native cellulose,*** *Melliand Textilber.* **33**, 485–8 (1952).

198. Mukherjee, S. M., Sikorski, J., and Woods, H. J., **Electron-microscopy of degraded cellulose fibres,** *J. Text. Inst.* **43**, T196–201 (1952) (Letter to the Editor).

199. Nobécourt, P., **Studies on the structure of plant cellular membranes,*** *Bull. assoc. tech. ind. papetière* **6**, 1–13 + 8 plates (1952) (*Bull. Inst. Paper Chem.* **22**, 740 (1952)).

200. Preston, R. D., **Fibrillar units in the structure of native cellulose,** *Discussions Faraday Soc.* **1951**, No. 11, 165–70 + 5 plates.

201. Preston, R. D., **"The molecular architecture of plant cell walls,"** New York, John Wiley and Sons, Inc., 1952, 211 pp. (Reviewed in *Bull. Inst. Paper Chem.* **23**, 307 (1953)).

202. Preston, R. D., Hermans, P. H., and Weidinger, A., **The crystalline-non-crystalline ratio in celluloses of biological interest,** *J. Exptl. Bot.* **1**, 344–52 (1950).

203. Rånby, B. G., **The cellulose micelles,** *Tappi* **35**, 53–8 (1952).

204. Rånby, B. G., **Fibrous macromolecular systems: Cellulose and muscle, the colloidal properties of cellulose micelles,** *Discussions Faraday Soc.* **1951**, No. 11, 158–64.

205. Rånby, B. G., **"Fine structure and reactions of native cellulose"** (Inaugural dissertation, University of Uppsala), Stockholm, Grafiska Konstanstalten Tryckeri AB, 1952, 22 pp. (in English).

206. Rånby, B. G., **The fine structure, crystallinity, and reactions of cellulose,*** *Bull. assoc. tech. ind. papetière* **6**, 67–78 (1952) (*Bull. Inst. Paper Chem.* **23**, 88 (1952)).

207. Rånby, B. G., **The physical characteristics of *alpha-*, *beta-*, and *gamma*-cellulose,** *Svensk Papperstidn.* **55**, 115–24 (1952) (in English).

208. Rånby, B. G., **Physico-chemical investigations on animal cellulose (Tunicin),** *Arkiv Kemi* **4**, 241–8 + 4 plates (1952) (in English).

209. Rånby, B. G., **Physico-chemical investigations on bacterial cellulose,** *Arkiv Kemi* **4**, 249–55 + 2 plates (1952) (in English).

210. Ritter, G. J., and Mitchell, R. L., **Fiber studies contributing to the differential shrinkage of cellulose,** *Paper Ind.* **33**, 1189–93 (1952) (*Chem. Abstracts* **46**, 3755i (1952)).

211. Schwertassek, K., **The relation between iodine absorption and crystallinity in cellulose fibers: V: Description of the method for determining iodine absorption, reduced iodine absorption, and normal mercerization,*** *Faserforsch. u. Textiltech.* **3**, 87–95 (1952).

212. Schwertassek, K., **The relation between iodine absorption and crystallinity in cellulose fibers: VI: The determination of the crystalline portion of cellulose on the basis of iodine absorption measurements,*** *Faserforsch. u. Textiltech.* **3**, 251–7 (1952).

213. Schwertassek, K., **The relation between iodine absorption and crystallinity in cellulose fibers: VIII: Detection of structural displacement in mechanical fiber damage by means of iodine absorption,*** *Faserforsch. u. Textiltech.* **3**, 477–82 (1952).

CELLULOSE FIBERS

214. Schwertassek, K., and Hájek, K., **The relation between iodine absorption and crystallinity in cellulose fibers: VII: The practical application of "revaluation diagrams" in the study of crystallization processes,*** *Faserforsch. u. Textiltech.* **3**, 349–54 (1952).

215. Staudinger, H., **Macromolecular compounds: [362] Cellulose: [105] Colloidal solutions of celluloses and their derivatives,*** *Bull. assoc. tech. ind. papetière* **6**, 89–103 (1952) (*Bull. Inst. Paper Chem.* **23**, 88 (1952)).

216. Staudinger, M., **Macromolecular compounds: [363] Cellulose: [106] The macromolecular or micellar structure of solid celluloses,*** *Bull. assoc. tech. ind. papetière* **6**, 103–19 (1952) (*Bull. Inst. Paper Chem.* **23**, 88 (1952)).

217. Wardrop, A. B., **The low-angle scattering of x-rays by conifer tracheids,** TEXTILE RESEARCH JOURNAL **22**, 288–91 (1952) (Letter to the Editor).

218. Weidinger, A., **X-ray diffraction analysis of fibrous materials,** in **"Symposium on the Physics of Fibrous Materials"** (collected papers), Arnhem, Holland, 1950, pp. 37–46.

219. Yurugi, T., and Imai, K., **Crystallization of cellulose fibers by acid treatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 383–5 (1950) (*Chem. Abtsracts* **46**, 6378e (1952)).

220. Zaides, A. L., and Sinitskaia, I. G., **Electronographic investigation of the native cellulose ramie,*** *Doklady Akad. Nauk S.S.S.R.* **80**, 213–14 (1951) (*Chem. Abstracts* **46**, 4786g (1952)).

See also [16, 34, 68, 286, 287, 318, 393, 439]

C. Mechanical Properties of Cellulose Fibers

221. Ashpole, D. K., **Correlation between initial Young's modulus and differential heat of sorption at zero regain for cellulosic fibres,** *Nature* **169**, 37–8 (1952) (Letter to the Editor).

222. Asmussen, R. W., Andersen, F., and Krawack, B., **The influence of solutions of salts on the elastic properties of cellulose fibers,** *Trans. Danish Acad. Techn. Sci.*, No. 5, 1950, 13 pp. (in English).

223. Dulitskaia, R. A., and Belenkii, L. I., **Relation between strength and structure of cotton fibers,*** *Tekstil. Prom.* **11**, No. 11, 33–4 (1951) (*J. Text. Inst.* **43**, A831 (1952)).

224. Finkelstein, T., Kargin, W., and Rogowin, S., **The alteration of the physico-mechanical properties of cellulose fibers under the action of high temperatures,*** *Textil-Praxis* **7**, 641–4 (1952).

225. Gibbons, G. C., and Harland, W. G., **Cellulose textile chemistry,** *Repts. Progr. Appl. Chem.* **36**, 525–45 (1951).

226. Kozlov, P. V., Zueva, R. V., and Bazhutina, I. B., **Relaxation processes during film formation,*** *Zhur. Fiz. Khim.* **25**, 1064–9 (1951) (*Chem. Abstracts* **46**, 3269h (1952)).

227. Luyken, E., and Wegener, W., **The influence of atmospheric conditions on the loading capacity of elongated rayon,*** *Melliand Textilber.* **33**, 767–70, 876–8 (1952).

228. Makishima, K., and Matsumoto, K., **Stretching of acetate rayon,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 447–9 (1950) (*Chem. Abstracts* **46**, 5849i (1952)).

229. Makishima, K., Matsumoto, K., and Adachi, T., **Saponification of acetate rayon under stretching: I: Saponification in aqueous sodium hydroxide solution,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 503–6 (1951) (*Chem. Abstracts* **46**, 5323f (1952)).

230. Makishima, K., and Sakai, J., **Stress-strain relationship of regenerated isotropic cellulose fibers in wet state,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 350–3 (1949) (*Chem. Abstracts* **46**, 4236i (1952)).

231. Matsuda, C., and Motoki, M., **On the behavior of fibrous and powder materials under the intense electrostatic field,*** *Tech. Repts. Eng. Research Inst. Kyoto Univ.* **1**, 29–51 (1951) (*Science Abstracts* **A55**, 325 (1952)).

232. Nagano, M., **Mechanical properties of cellulose fibers as a function of the molecular distribution: I: Theoretical strength,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 385–7 (1951) (*Chem. Abstracts* **46**, 5833e (1952)).

233. Nagano, M., and Murakami, K., **Mechanical properties of cellulose fibers as a function of the molecular distribution: III: Rayon staples,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 546–9 (1951) (*Chem. Abstracts* **46**, 5833f (1952)).

234. Negishi, M., Fukuda, K., and Mori, H., **Elasticity, tensile properties, and the mechanism of deformation of fibers: IV: Tensile properties of natural, hydrated, and water cellulose cotton fibers in water and caustic alkali solutions,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 266–8 (1949) (*Chem. Abstracts* **46**, 3756i (1952)).

235. Negishi, M., Fukuda, K., Mori, H., Inagawa, K., and Arai, Y., **Elasticity, tensile properties, and the mechanism of deformation of fibers: III: Tensile properties of natural cotton fibers in organic liquids,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 222–4 (1949) (*Chem. Abstracts* **46**, 3756h (1952)).

236. Negishi, M., Shoji, F., Mori, H., and Ito, H., **Elasticity, tensile properties and the mechanism of deformation of fibers: I: Influence of humidity of air on the elastic recovery of cellulose fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 178–80 (1949) (*Chem. Abstracts* **46**, 3756f (1952)).

237. Negishi, M., Shoji, F., Mori, H., and Ito, H., **Elasticity, tensile properties, and the mechanism of deformation of fibers: II: Influence of humidity of air on the strain-stress curve of cotton fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 219–21 (1949) (*Chem. Abstracts* **46**, 3756g (1952)).

238. Nikitina, N. I., and Klenkova, N. I., **The influence of weak alkylation on the properties of a cellulose fiber,*** *Zhur. Priklad. Khim.* **24**, 296–307 (1951) (*Chem. Abstracts* **46**, 733f (1952)).

239. Okamura, I., **Maximum safe tension for rayon at higher humidities,** *Teijin Times* **22**, No. 6, 3–4 (1952) (in English).

240. Okamura, I., **Tensile strength of rayon in wet state,** *Teijin Times* **22**, No. 3, 3–7 (1952) (in English).

241. Pakshver, A. B., Frolov, S. S., and Filatova, N. N., **Hygroscopicity and elongation (in water) of viscose and cuprammonium rayon fibers,*** *Tekstil. Prom.* **10**, No. 12, 18–20 (1950) (*Chem. Abstracts* **46**, 6390e (1952)).

242. Suda, T., **Stretching of cellulose derivative films: VIII: Cellulose acetate films containing a plasticizer,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 175–9 (1952) (*Chem. Abstracts* **46**, 9840g (1952)).

243. Sumida, R., **Stretching of cellulose acetate films,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 253–7 (1950) (*Chem. Abstracts* **46**, 4803g (1952)).

244. Suzuki, A., and Narita, T., **Physical properties of viscose fibers and their fabrics,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 130–3 (1952) (*Chem. Abstracts* **46**, 8861d (1952)).

245. de Vries, H., **The dynamic modulus of elasticity of regenerated cellulose fibres in relation to large deformation,** *Applied Sci. Research* **A3**, 111–24 (1951).

246. Wegener, W., **Dynamic stress-strain properties of viscose rayon,*** *Z. ges. Textil-Ind.* **54**, 10–14, 71–5, 105–12 (1952).

247. Wegener, W., and Genthe, K., **Elongation-tension diagrams of various silks and synthetic fibers obtained at constant rate of extension and with free fall,*** *Melliand Textilber.* **33**, 130–4, 234–7 (1952).

248. Wegener, W., and Luyken, E., **Tension of viscose rayon as a function of time, elongation, and relative humidity,*** *Melliand Textilber.* **33**, 37–9 (1952).

See also [774]

D. Absorption and Swelling of Cellulose

249. Ashpole, D. K., **The moisture relations of textile fibres at high humidities,** *Proc. Roy. Soc.* (London) **A212**, 112–23 (1952).

250. Carroll, M., and Mason, S. G., **The measurement of fiber swelling by the liquid permeability method,** *Can. J. Technol.* **30**, 321–33 (1952).

251. Elfving, L., **Adsorption of ammonia by cellulose,*** *Svensk Papperstidn.* **55**, 794–5 (1952).

252. Farrar, J., and Neale, S. M., **The distribution of ions between cellulose and solutions of electrolyte,** *J. Colloid Sci.* **7**, 186–95 (1952).

253. Giuffria, R., and Tripp, V. W., **Effects of tension on the swelling of cotton fibers,** TEXTILE RESEARCH JOURNAL **22**, 21–5 (1952).

254. Grinberg, B., **"Contribution to the study of the sorption of water vapor by cellulose"*** (Doctorate thesis, Faculty of Sciences, University of Paris, Series A, 2343, No. 3215), Paris, Masson et Cie., 1951, 47 pp.

255. Grotjahn, H., and Hess, K., **Effect of method of preparation on the inner surface of cellulose,*** *Kolloid-Z.* **129**, 128–32 (1952).

256. Hearle, J. W. S., **A note on Pierce's two-phase theory of absorption of water by cellulose,** *J. Text. Inst.* **43**, T354 (1952) (Letter to the Editor).

257. Hirsch, P., **The behaviour of membranes between electrolyte solutions: I: The relation between pH and the membrane potential across cellophane,** *Rec. trav. chim.* **70**, 567–77 (1951) (in English).

258. Hirsch, P., **The behaviour of membranes between electrolyte solutions: II: Membrane potentials at oxidized cellophane,** *Rec. trav. chim.* **71**, 354–60 (1952) (in English).

259. Krzystek, H., **Improving the tenacity and increasing the swelling of viscose rayon,*** *Prace Głównego Inst. Włókiennictwa*, No. 5, 47–58 (1952) (*Faserforsch u. Textiltech.* **3**, 511 (1952)).

260. Kurosaki, S., **Dielectric properties of sorbed water: II: Capillary condensation theory on the sorbed water in several high polymer films,*** *J. Chem. Soc. Japan*, Pure Chem. Sect., **72**, 688–91 (1951) (*Chem. Abstracts* **46**, 1316c (1952)).

261. Magne, F. C., and Skau, E. L., **Nonfreezing water and nonfreezing benzene capacities of cottons and modified cottons,** TEXTILE RESEARCH JOURNAL **22**, 748–56 (1952).

262. Mongar, I. L., and Wassermann, A., **Heat effects accompanying the absorption of simple electrolytes by fully-swollen alginate and cellulose gels: A new microcalorimetric method,** *J. Chem. Soc.* **1952**, 510–13.

263. Morehead, F. F., **A method for studying the effect of humidity on the cross-sectional swelling of some common fibers,** TEXTILE RESEARCH JOURNAL **22**, 535–9 (1952).

264. Neale, S. M., and Standring, P. T., **The measurement of Donnan potentials with cellulose and aqueous solutions,** *Proc. Roy. Soc.* (London) **A213**, 530–45 (1952).

265. Okamura, I., **Drying of regenerated cellulose fiber,** *Teijin Times* **22**, No. 4, 4–5 (1952) (in English).

266. Pinte, J., **The swelling and swelling anisotropy of rayon,*** *Melliand Textilber.* **33**, 699–704 (1952).

267. Richter, G. A., Herdle, L. E., and Wahtera, W. E., **Vapor sorption of cellulose at high relative humidities,** *Ind. Eng. Chem.* **44**, 2883–93 (1952).

268. Ruckstuhl, C., and Durig, G., **Study of parameters involved in the determination of swelling by weight of viscose rayon,*** *Bull. inst. text. France*, No. 33, 9–20 (1952).

269. Taylor, J. B., **Sorption of water by viscose rayon at low humidities,** *J. Text. Inst.* **43**, T489–515 (1952).

270. Vermaas, D., **The absorption and desorption of water by rayon,** *Rayon Rev.* **5**, 39–45 (1951) (English edition).

271. Ward, A. F. H., and Tordai, L., **Time-dependence of surface tensions of solutions: II: Experimental determination of the kinetics and equilibrium of adsorption at liquid-liquid interfaces,** *Rec. trav. chim.* **71**, 396–408 (1952) (in English).

272. Welo, L. A., Ziifle, H. M., and Loeb, L., **Swelling capacities of fibers in water: I: Desiccation rate measurements,** TEXTILE RESEARCH JOURNAL **22**, 254–61 (1952).

273. Welo, L. A., Ziifle, H. M., and McDonald, A. W., **Swelling capacities of fibers in water: II: Centrifuge studies,** TEXTILE RESEARCH JOURNAL **22**, 261–73 (1952).

See also [314, 1681, 1683, 1686, 1687, 1689, 1738, 1993]

E. Cotton Fibers

274. Brixhe, A., and Fransen, T., **Preliminary color measurements on Belgian Congo cottons,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 195–225 (in French).

275. Buck, G. S., Jr., **An analysis of the consumer quality characteristics of cotton: Implications for research,** TEXTILE RESEARCH JOURNAL **22**, 117–22 (1952).

276. Chilinkin, M. M., **Chemistry of contaminated cotton,*** *Tekstil. Prom.* **9**, No. 11, 20–2 (1949) (*Chem. Abstracts* **46**, 4804i (1952)).

277. Fisher, C. H., **Cotton studies at the Southern Regional Research Laboratory,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 187–94 (in English).

CELLULOSE FIBERS

278. Gerdes, F. L., **Quality evaluations and improvements basic to providing users of U. S. cotton with a better product,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 9–17.

279. Grant, J. N., Morlier, O. W., and Scott, J. M., **Effects of mechanical processing of cotton on the physical properties of fibers,** TEXTILE RESEARCH JOURNAL **22**, 682–7 (1952).

280. Grimes, M. A., **Cotton defoliation and fiber maturity,** TEXTILE RESEARCH JOURNAL **22**, 637–40 (1952).

281. Hall, L. T., and Elting, J. P., **Cavitomic cotton,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 269–81 (in English).

282. Hertel, K. L., and Craven, C. J., **Cotton fineness and immaturity as measured by the Arealometer,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 239–48 (in English).

283. Hoffpauir, C. L., **Cotton's minor constituents: Their role in utilization,** *Textile Inds.* **116**, No. 8, 109–13 (1952).

284. Hopper, T. H., **Check sample testing of physical properties of cotton with instruments: A summary report prepared for the Task Group on Inter-Laboratory Check Sample Testing of Cotton Fibers,** TEXTILE RESEARCH JOURNAL **22**, 472–5 (1952).

285. Kling, W., and Mahl, H., **The morphology of cotton: II: The bacterial degradation of the cotton fiber and structural elements of the secondary wall,*** *Melliand Textilber.* **33**, 32–7 (1952).

286. Kling, W., and Mahl, H., **The morphology of cotton: III: Electro-microscopic examination of fiber cross-sections,*** *Melliand Textilber.* **33**, 328–31 (1952).

287. Kling, W., and Mahl, H., **The morphology of cotton: IV: Relation of the experimental results to a new, improved fiber model,*** *Melliand Textilber.* **33**, 829–32 (1952).

288. Marsh, P. B., Guthrie, L. R., and Butler, M. L., **The influence of weathering and of microorganisms on the aqueous extract of pH of cotton fiber,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 283–301 (in English).

289. de Meulemeester, D., Tison, L., Raes, G., and Fransen, T., **Permeability measurements of cotton samples as influenced by the gravimetric fineness and the maturity,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 249–68 (in French).

290. Nickerson, D., **"Effect of exposure and storage on color and other factors of quality in raw cotton,"** Washington, D. C., U. S. Dept. of Agriculture, Production and Marketing Administration, Cotton Branch, Jan. 1951, 27 pp.

291. Orr, R. S., Humphreys, G. C., and Grant, J. N., **Influence of cross-sectional shape of raw cotton on dimensional changes in mercerization without tension,** TEXTILE RESEARCH JOURNAL **22**, 89–93 (1952).

292. Pons, W. A., Jr., and Hoffpauir, C. L., **Colorimetric determination of the pH of cotton fiber,** TEXTILE RESEARCH JOURNAL **22**, 200–2 (1952).

293. Rostovtsev, V. E., **The process of alkaline boiling of cotton products,*** *Zhur. Priklad. Khim.* **24**, 976–80 (1951) (*Chem. Abstracts* **46**, 6377h (1952)).

294. Schuringa, G. J., Meeuse, A. D. J., de Meulemeester, D., Raes, G., and vanden Abeele, A. M., **Comparison of methods of testing degree of maturity of cotton,*** *Mededel. Vezelinst. T.N.O.*, No. 103, Delft, 1950, 55 pp. (in French and Dutch).

295. Tripp, V. W., and Rollins, M. L., **Morphology and chemical composition of certain components of cotton fiber cell wall,** *Anal. Chem.* **24**, 1721–8 (1952).

See also [1189]

F. Bast and Hard Fibers

1. General

296. Hubert, J., **Portable plant defibrating machines,*** *Melliand Textilber.* **33**, 1085–7 (1952).

297. de Meulemeester, D., Raes, G., and de Clercq, G., **The rigidity properties of bast and hard fibers,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 313–27 (in French).

298. Nobécourt, P., and Chiaverina, J.-O., **Studies on the structure of vegetable fibers,*** *Ann. Inst. Polytechnique Grenoble*, Special Number, 127–33 + 4 plates (1952) (*Bull. Inst. Paper Chem.* **22**, 906 (1952)).

299. Shearon, W. H., Jr., **Natural fibers,** *Chem. Eng. News* **30**, 1618–21 (1952).

300. Tobler, F., **Comparison of biological, chemical, and mechanical methods for separating plant fibers: Review of present development,*** *Textil-Rundschau* **7**, 102–5 (1952).

301. Tobler-Wolff, F., and Tobler-Wolff, G., **"Microscopic examination of plant fibers,"*** Leipzig, S. Hirzel Verlag, 171 pp. (reviewed in *Melliand Textilber.* **34**, 85 (1953)).

2. Jute

302. Basu, S. N., and Ghose, S. N., **Fungal decomposition of jute fibre and cellulose: III: The decomposition of cellulose as influenced by its physical state and by associated substances,** *J. Text. Inst.* **43**, T278–89 (1952).

303. Bell, W. A., **The retention of organic liquids by jute,** *J. Text. Inst.* **43**, T595–7 (1952) (Letter to the Editor).

304. Bhattacharjee, H. P., and Callow, H. J., **Action of dilute caustic soda solution on jute fibre: I: Hydrolysis of ester linkages,** *J. Text. Inst.* **43**, T53–9 (1952).

305. Callow, H. J., **Acetylation of cellulose and lignin in jute fibre,** *J. Indian Chem. Soc.* **28**, 605–10 (1951).

306. Callow, H. J., **Acetylation of jute,** *J. Text. Inst.* **43**, T423–32 (1952).

307. Callow, H. J., **Delignification of jute with sodium chlorite,** *J. Text. Inst.* **43**, T247–9 (1952) (Letter to the Editor).

308. Das, D. B., Mitra, M. K., and Wareham, J. F., **Action of hydrogen peroxide on jute,** *J. Text. Inst.* **43**, T443–53 (1952).

309. Das, D. B., and Wareham, J. F., **Effect of relative humidity on the strength of jute yarns,** *Textile Inds. and Fibres* **13**, 78–81 (1952).

310. Das Gupta, P. C., Tripathi, I. L., Roy, S. C., and Sen, M. K., **The oiling of jute,** *Textile Manufacturer* **78**, 410–14 (1952).

311. Macmillan, W. G., Sen Gupta, A. B., and Roy, A., **Observations on the determination of lignin in jute,** *J. Text. Inst.* **43**, T103–11 (1952).
312. Mitra, M. K., **The structure of jute,** *Science and Culture* (India) **17**, 67–71 (1951) (*Chem. Abstracts* **46**, 4786f (1952)).
313. Pal, K. B., Chatterjee, H., and Sarkar, P. B., **Molecular weight of jute *alpha*-cellulose,** *Nature* **169**, 845–6 (1952) (Letter to the Editor).
314. Roy, M. M., and Sen, M. K., **The swelling of jute fibre in water: Transverse swelling,** *J. Text. Inst.* **43**, T396–401 (1952).
315. Sarkar, P. B., **Acetyl groups in jute fibre,** *J. Text. Inst.* **43**, T290 (1952) (Letter to the Editor).
316. Sarkar, P. B., **Mesta or Bimlipatam jute,** *Textile Manufacturer* **78**, 358–9 (1952).
317. Sarkar, P. B., Mazumdar, A. K., and Pal, K. B., **The nature of the hemicelluloses of jute fiber: I,** TEXTILE RESEARCH JOURNAL **22**, 529–34 (1952).
318. Sen, M. K., and Mukherjee, R. R., **The structure of jute: I: The x-ray diffraction pattern,** *J. Text. Inst.* **43**, P114–21 (1952).

See also [1458]

3. Other Bast Fibers

319. Anon., **Botany of flax,** *Nature* **170**, 557–9 (1952).
320. Blümcke, A., **Economic significance and prospects of kenaf,*** *Melliand Textilber.* **33**, 1001–2 (1952).
321. Caldwell, S. A. G., **Ramie: I,** *Textile Inds. and Fibres* **13**, 390–3 (1952).
322. Denis, R. A., **Ramie,*** *Melliand Textilber.* **33**, 909–10 (1952).
323. Kop'ev, A. A., and Dul'man, T. M., **New method for the biological retting of flax by the aid of denitrifying bacteria,*** *Tekstil. Prom.* **12**, No. 6, 21–3 (1952) (*J. Soc. Dyers and Colourists* **69**, 67 (1953)).
324. Krebs, G., **Spinning, weaving, and finishing of "green kenaf,"*** *Melliand Textilber.* **33**, 919–20 (1952).
325. Lüdtke, M., **Investigation of chemical processes in the water-retting of flax,*** *Melliand Textilber.* **33**, 107–11 (1952).
326. Luniak, B., **The strength of ramie* (with remarks by R. Klar),** *Melliand Textilber.* **33**, 910–11 (1952).
327. Maillard, F., and Szymanek, J., **Observations on the production of linen fibers,*** *Bull. inst. text. France*, No. 30, 289–313 + 6 pp. figures and tables (1952).
328. McCann, L. P., **"Kenaf (*Hibiscus cannabinus* L.),"** U. S. Dept. of Agriculture, Bibliographical Bulletin No. 17, Washington, D. C., U. S. Govt. Print. Off., 1952, 20 pp.
329. Menzel, K. C., **The retting of flax,*** *Faserforsch. u. Textiltech.* **3**, 105–9 (1952).
330. Roehrich, O., **Contribution to the study of the mechanical characteristics of ramie fibers,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 303–11 (in French).
331. Salbert, J., **Will male or female hemp give fine or coarse cloth?*** *Industrie textile* **68**, 557–9 (1951) (*Chem. Abstracts* **46**, 4801g (1952)).
332. Vautrin, C., **How is degumming and bleaching of ramie carried out in China?*** *Industrie textile* **67**, 333–4 (1950) (*Chem. Abstracts* **46**, 4240e (1952)).

See also [1497, 1500, 1503, 1528, 1529, 1532]

4. Hard Fibers

333. Grindrod, J., **New system of drying sisal: An inclusive treatment,** *Textile Inds. and Fibres* **13**, 225–8 (1952).
334. Lohani, B. K., Biswas, B., and Dhingra, D. R., **Comparative study of agave fibers prepared by different methods,** *J. Proc. Inst. Chemists* (India) **24**, Pt. 1, 39–47 (1952) (*Chem. Abstracts* **46**, 8859c (1952)).
335. Thieme, J. G., **Analysis of fiber length of sisal tow,** *Textile Quart.* **1**, 335–8 (1951) (*J. Text. Inst.* **43**, A251 (1952)).
336. Thieme, J. G., **Progress and possibilities of the sisal industry,*** *Textil-Praxis* **7**, 3–5 (1952).

G. Rayon Fibers

1. Viscose Process

(a) Pulp Characterization and Reactions with Alkali

337. Heide, K., **Quality estimation of cellulose pulp,*** *Faserforsch. u. Textiltech.* **3**, 465–77 (1952).
338. Nagano, M., and Fujiwara, M., **Reactivity of rayon pulps: II: Change of the reactivity by pretreatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 183–6 (1952) (*Chem. Abstracts* **46**, 9302c (1952)).
339. Nagano, M., and Fujiwara, M., **Reactivity of rayon pulp: III: Relation between the filterability of viscose and the quality of pulp,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 331–4 (1952) (*Chem. Abstracts* **46**, 9840c (1952)).
340. Nagano, M., and Yoshioka, Y., **Aging of alkali cellulose: IV: Degradation of cellulose by oxidation and hydrolysis,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 275–9 (1950) (*Chem. Abstracts* **46**, 6379e (1952)).
341. Sihtola, H., and Boström, B., **Investigations on the viscose process: I: Influence of catalysts in the ageing of alkali cellulose,** *Paper and Timber* (Finland) **34**, No. 2, 23–7 (1952) (in English).
342. Yurugi, T., and Furuya, H., **Fundamental studies on the estimation of the quality of rayon pulp: II: Effect of the fine structure of mercerized pulp on the viscose process,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 87–90 (1950) (*Chem. Abstracts* **46**, 4222g (1952)).

See also [170]

(b) Xanthation

343. Hess, K., Kiessig, H., and Koblitz, W., **The permutoid character of xanthation of fibrous cellulose,*** *Z. Elektrochem.* **55**, 697–708 (1951); *Naturwissenschaften* **38**, 433–4 (1951).
344. Ikoma, I., Ohira, M., and Kato, H., **Artificial fibers containing melamine-formaldehyde resin,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 208–11 (1949) (*Chem. Abstracts* **46**, 3764d (1952)).
345. Karlinsky, N., and Chmelik, B., **Absorption of alkali as related to viscose production,*** *Papir a celulosa, Prag* **7**, No. 2, 38–41 (1952) (*Faserforsch. u. Textiltech.* **3**, 463 (1952)).
346. Komarov, F. P., **Preparation of viscose pulp with a high reactivity,*** *Bumazh. Prom.* **27**, No. 9, 6–9 (1952) (*Chem. Abstracts* **47**, 308e (1953)).
347. Kuriyama, S., and Mihara, K., **Variation of microstructure of cellulose in viscose during xanthation and aging,*** *Kôgaku Ihô, Kyushu Univ.* **24**, 28–31 (1951) (*Chem. Abstracts* **47**, 1384f (1953)).

CELLULOSE FIBERS

348. Kuriyama, S., and Shiratsuchi, E., **Xanthation of the alkali cellulose fiber: I: Mechanism of the xanthation of alkali cellulose fiber and the influence of press ratio on xanthation,*** *J. Chem. Soc. Japan,* Ind. Chem. Sect., **54**, 62–4 (1951) (*Chem. Abstracts* **47**, 1384g (1953)).

349. Nagano, M., and Yoshioka, Y., **Xanthation of alkali cellulose: III: Wet process,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 213–14 (1950) (*Chem. Abstracts* **46**, 6392a (1952)).

350. Noguchi, T., **Xanthation in the viscose process: I: Influence of composition of alkali cellulose and xanthating conditions upon the degree of xanthation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 153–5 (1950) (*Chem. Abstracts* **46**, 5834i (1952)).

351. Noguchi, T., **Xanthation in the viscose process: II: Collapse of the micellar structure with xanthation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 155–7 (1950) (*Chem. Abstracts* **46**, 5835a (1952)).

352. Noguchi, T., **Xanthation in the viscose process: IV: Change of molar ratio between the reacted and unreacted cellulose-glucose units in sodium cellulose xanthate with the progress of xanthation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 217–19 (1950) (*Chem. Abstracts* **46**, 5835b (1952)).

353. Noguchi, T., **Xanthation in the viscose process: X: Reaction mechanism of xanthation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 444–6 (1950) (*Chem. Abstracts* **46**, 5835e (1952)).

354. Schramek, W., and Ahrberg, L., **The swelling and solution mechanism of soda-pulp fibers: VII,*** *Holzforschung* **5**, 97–106 (1951) (*Chem. Abstracts* **46**, 6378a (1952)).

See also [150]

(c) *Properties of Viscose Solutions*

355. Kobayashi, H., and Kagawa, I., **Ripening reactions of viscose: I: Mechanism and velocity of the decomposition of cellulose xanthate,*** *J. Chem. Soc. Japan,* Ind. Chem. Sect., **53**, 249–51 (1950) (*Chem. Abstracts* **46**, 10614d (1952)).

356. Kobayashi, H., and Kagawa, I., **Ripening reactions of viscose: II: Variation of the amount of various salts during the course of viscose ripening,*** *J. Chem. Soc. Japan,* Ind. Chem. Sect., **53**, 289–91 (1950) (*Chem. Abstracts* **46**, 11674c (1952)).

357. Kohlitz, W., **A new method for the quantitative determination of gel particles in colloidal solutions, especially in viscose,*** *Reyon Zellwolle u. Chemiefasern* **30**, 343–6 (1952).

358. Matthes, A., **The ripening mechanism of viscose,*** *Faserforsch. u. Textiltech.* **3**, 127–41 (1952).

359. Mikhailov, N. V., Maiboroda, V. I., and Kargin, V. A., **New data on the kinetics of the ripening of viscose,*** *Kolloid Zhur.* **14**, 57–65 (1952) (*Chem. Abstracts* **46**, 4790h (1952)).

360. Nagano, M., and Ochi, Y., **Xanthation of alkali cellulose: IV: Properties of viscose prepared by the wet process,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 80–2 (1951) (*Chem. Abstracts* **46**, 6392b (1952)).

361. Noguchi, T., **Xanthation in the viscose process: III: A stable compound from sodium cellulose xanthate by substituting the dithiocarbonic group by a methyl radical,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 215–16 (1950) (*Chem. Abstracts* **46**, 5835a (1952)).

362. Noguchi, T., **Xanthation in the viscose process: V: Distribution of esterified glucose units,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 270–3 (1950) (*Chem. Abstracts* **46**, 5835c (1952)).

363. Noguchi, T., **Xanthation in the viscose process: VI: Intraglucosic structure (especially at C-2) of sodium cellulose xanthate,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 312–14 (1950) (*Chem. Abstracts* **46**, 5835c (1952)).

364. Noguchi, T., **Xanthation in the viscose process: VIII: Intraglucosic structure (especially at C-6) of sodium cellulose xanthate,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 379–81 (1950) (*Chem. Abstracts* **46**, 5835d (1952)).

365. Noguchi, T., **Xanthation in the viscose process: IX: Determination of intraglucosic structure of sodium cellulose xanthate,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 381–2 (1950) (*Chem. Abstracts* **46**, 5835e (1952)).

366. Samuelson, O., and Jonsén, H., **Investigations concerning the filtering properties of viscose: VI: Influence of variations in the sodium hydroxide concentration during the dissolution of cellulose xanthate,** *Svensk Papperstidn.* **55**, 933–5 (1952) (in English).

367. Scherer, P. C., and Chinai, S. N., **Effect of initial sulfur-cellulose ratio on that of viscose syrup at maturity,** *Rayon and Synthetic Texts.* **33**, No. 2, 38, 41–2 (1952).

368. Treiber, E., Koren, H., Felbinger, W., and Lang, W., **Contribution to the study of viscose decomposition: The dissociation constant of cellulose xanthic acid,*** *Monatsh.* **83**, 259–70 (1952).

369. Treiber, E., Porod, G., and Lang, W., ***Ortho* form of xanthogenates: Contribution to the knowledge of viscose, III,*** *Österr. Chem.-Ztg.* **53**, 162–7 (1952) (*Chem. Abstracts* **46**, 11674a (1952)).

370. Yurugi, T., **Viscose: X: Ripening of low-alkali viscose,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 97–100 (1950) (*Chem. Abstracts* **46**, 6379g (1952)).

See also [801]

(d) *Regeneration*

371. Herrent, P., **The internal structure of cellulosic gels and their mechanical behavior,*** *Ind. chim. belge* **17**, 355–60 (1952) (in French) (*Chem. Abstracts* **46**, 10612c (1952)).

372. Kleinert, T., **Bound lime in regenerated cellulose fibers and its behavior in the viscose process: II: Influence on viscose filtration,*** *Textil-Rundschau* **7**, 98–102 (1952).

373. Nagano, M., and Yoshioka, Y., **Mechanism of viscose spinning: I: Viscose regeneration from the ternary system of sulfuric acid, sodium, and zinc sulfates,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 90–4 (1950) (*Chem. Abstracts* **46**, 6827b (1952)).

374. Nagano, M., and Yoshioka, Y., **Mechanism of viscose spinning: II: Viscose regeneration from sulfuric acid mixed with various metallic salts,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 95–7 (1950) (*Chem. Abstracts* **46**, 6827d (1952)).

375. Pariaud, J. C., and Ferrier, J., **Conductivities of the quaternary solutions of water-sulfuric acid-sodium sulfate-zinc sulfate capable of regenerating cellulose from viscose,*** *Bull. soc. chim. France* **1952**, 227–9.

376. Takahashi, N., and Asaeda, T., **Electron-microscope study of the phenomenon of mechanical polishing during manufacture of artificial silk,*** *Bull. inst. text. France*, No. 35, 75–82 + 3 plates (1952).
377. Thomas, C. R. W., **Continuous production of chemical fiber on the Kuljian system,*** *Melliand Textilber.* **33**, 711–14 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 347–52 (1952).
378. Wehrung, A., **The precipitating bath and (its relation to) filament shape in viscose processing,*** *Reyon Zellwolle u. Chemiefasern* **30**, 524–30 (1952).

See also [612]

(c) *Orientation*

379. Brötz, A., **Tire-cord rayon,*** *Das Papier* **6**, 368–72 (1952).
380. Okajima, S., and Hayama, S., **Plastic deformation of regenerated cellulose fibers: II: Deformation of freshly prepared fibers from the standpoint of refractive indexes,*** *Bull. Chem. Soc. Japan* **24**, 90–3 (1951) (*Chem. Abstracts* **46**, 6377g (1952)).
381. Okajima, S., and Kobayashi, Y., **Plastic deformation of regenerated cellulose fibers: I: Dichroic study of the deformation of freshly prepared fibers,*** *Bull. Chem. Soc. Japan* **24**, 85–90 (1951) (*Chem. Abstracts* **46**, 6377d (1952)).
382. Pinte, J., Rochas, P., and Henno, J., **Physico-chemical studies of the structural modifications of viscose rayon caused by drawing the filaments,*** *Bull. inst. text. France*, No. 30, 141–76 (1952).

2. *Acetate Process*

383. Makishima, K., Matsumoto, K., and Haga, M., **Saponification of acetate rayon under stretching: II: Relation between acetylation and direct dye absorption,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 432–5 (1952) (*Chem. Abstracts* **47**, 326b (1953)).
384. Makishima, K., Matsumoto, K., and Haga, M., **Saponification of acetate rayon under stretching: III: Saponification with sodium hydroxide-methanol mixture,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 435–8 (1952) (*Chem. Abstracts* **47**, 326d (1953)).
385. Sippel, A., **Manufacture and use of highly oriented acetate rayon,*** *Textil-Praxis* **7**, 574–6 (1952).
386. Suda, T., **Stretching of cellulose derivative films: VII: Double refraction of stretched films,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 172–5 (1952) (*Chem. Abstracts* **46**, 9840f (1952)).
387. Urquhart, A. R., **Cellulose acetate rayon,*** *Rayonne et fibres synthét.* **8**, No. 6, 60–6 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 362–70 (1952).
388. Yurugi, T., and Imai, K., **Saponification of cellulose acetate fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 506–9 (1951) (*Chem. Abstracts* **46**, 4236i (1952)).

See also [106–131, 228, 229]

3. *Structure*

389. Avisiers, I., **Microscopic investigations on milkiness of viscose rayon,*** *Melliand Textilber.* **33**, 331–5 (1952).
390. Centola, C., **The influence of the structure of cellulose on certain properties of artificial fibers,*** *Bull. inst. text. France*, No. 30, 131–9 (1952).
391. Chamberlain, N. H., and Khera, M. P., **Radial heterogeneity in viscose and cuprammonium filaments,** *J. Text. Inst.* **43**, T123–57 (1952).
392. Elöd, E., and Kramer, M., **The relation between fine structure and crease properties of viscose rayon,*** *Textil-Praxis* **7**, 623–5 (1952).
393. Hermans, P. H., and Heikens, D., **Correlation between sensitivity to acid hydrolysis and skin-core differentiation in viscose rayon,** *J. Polymer Sci.* **8**, 187–90 (1952).
394. Okajima, S., Hayama, S., and Kobayashi, K., **Heterogeneous structure of rayon: I: Some observations on the heterogeneous acetylation of rayon,** *Bull. Chem. Soc. Japan* **25**, 271–5 (1952) (in English).
395. Okajima, S., Hayama, S., and Kobayashi, K., **Heterogeneous structure of rayon: II: Orientation degree of the skin and core of rayons,** *Bull. Chem. Soc. Japan* **25**, 275–9 (1952) (in English).
396. Pakshver, A. B., Mankash, E. K., and Kukonkova, A. I., **Estimation of the structural non-uniformity of rayon,*** *Tekstil. Prom.* **11**, No. 11, 13–15 (1951); *Faserforsch. u. Textiltech.* **3**, 199–201 (1952).
397. Tachikawa, S., **Micro-spun rayon fiber,** *Rayon and Synthetic Texts.* **33**, No. 3, 34–5, 56 (1952).

See also [173–220, 1095]

III. PROTEIN FIBERS

A. *Wool and Other Hair Fibers*

1. *General*

398. Auber, L., **The anatomy of follicles producing wool fibres, with special reference to keratinization,** *Trans. Roy. Soc. Edinburgh* **62**, 191–254 (1949–51).
399. Carter, E. G., **Apparel wool fibers,*** *Bull. inst. text. France*, No. 30, 229–53 + 1 p. figures (1952).
400. Mecheels, O., **Physiological and chemical properties of wool,*** *Melliand Textilber.* **33**, 275–80 (1952).
401. von Bergen, W., **What's new in wool research,** *Natl. Wool Grower* **42**, 31–6 (1952).
402. Zahn, H., **New research findings on wool,*** *Textil-Rundschau* **7**, 305–19 (1952).

2. *Morphology*

403. Algera, L., **The visibility of the "cuticula" of wool under the phase-contrast microscope,** TEXTILE RESEARCH JOURNAL **22**, 97–8 (1952) (Letter to the Editor).
404. Ames, J., **An electron microscope study of the wool fibre cuticle,** *J. Text. Inst.* **43**, T262–7 (1952).
405. Elliott, R. L., and Manogue, B., **An electron microscope study of the surface structure of wool,** *J. Soc. Dyers and Colourists* **68**, 12–14 (1952).
406. Ford, O. E., **The deposition of polymers on the wool fiber and the Allwörden reaction,*** *Melliand Textilber.* **33**, 597 (1952).
407. Herzog, A., **Causes of the natural coloring of animal and vegetable fiber materials,*** *Melliand Textilber.* **33**, 1073–6 (1952).
408. Jagger, L. G., and Speakman, J. B., **The pore size of keratin,** *J. Text. Inst.* **43**, T67–8 (1952) (Letter to the Editor).
409. Lagermalm, G., **The epicuticle of wool—some results of current investigations,*** *Medd. Svenska Textilforskningsinst.*, No. 14, 65–9 (1951) (*Chem. Abstracts* **46**, 2302e (1952)).

PROTEIN FIBERS

410. Lagermalm, G., and Gralén, N., **Some chemical data concerning the epicuticle of wool,** *Acta Chem. Scand.* **5**, 1209–10 (1951) (in English).

411. Lang, W. R., **Wool fibre contour: Its significance to the mechanical properties of the fibre,** *J. Text. Inst.* **43**, P245–51 (1952).

412. Leveau, M., Derminot, J., and Parisot, A., **Structure of the wool fiber,*** *Bull. inst. text. France,* No. 35, 9–24 + 4 plates (1952).

413. Leveau, M., Langlois, J., and Parisot, A., **A new aspect of the Allwörden reaction: Action of bromine water on wool and other animal fibers,*** *Bull. inst. text. France,* No. 34, 9–14 + 4 plates (1952).

414. Maillard, F., and Szymanek, J., **Contribution to the knowledge of the microanatomical structure of the wool fiber,*** *Compt. rend.* **233**, 100–2 (1951).

415. Mercer, E. H., **The wool fibre,** *Textile Manufacturer* **78**, 381 (1952).

416. Miyasaka, K., and Onishi, K., **Fibrillar structure of fibers: II: Animal fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 389–91 (1951) (*Chem. Abstracts* **46**, 4802e (1952)).

417. Moncrieff, R. W., **The sub-cuticle of wool,** *Textile Manufacturer* **78**, 149–50 (1952).

418. Pearse, A. G. E., **The histochemical demonstration of keratin by methods involving selective oxidation,** *Quart. J. Microscop. Sci.* **92**, 393–402 (1951).

419. Schuringa, G. J., Algera, L., Isings, J., and Ultée, A. J., Jr., **A note on the epicuticle of wool,*** *Experientia* **8**, 57–60 (1952) (in German).

420. Schuringa, G. J., Isings, J., and Ultée, A. J., Jr., **The chemical composition of the epicuticle of wool: I: The protein character of the epicuticle,** *Biochim. et Biophys. Acta* **9**, 457–67 (1952) (in English).

421. Schuringa, G. J., Schooneveldt, C. J., and Ultée, A. J., Jr., **The chemical composition of the epicuticle of wool: II: Cross-linking in epicuticle protein,** *Biochim. et Biophys. Acta* **9**, 506–14 (1952) (in English).

3. Fine Structure

422. Bamford, C. H., Brown, L., Elliott, A., Hanby, W. E., and Trotter, I. F., **Structure of synthetic polypeptides,** *Nature* **169**, 357–8 (1952).

423. Bamford, C. H., and Hanby, W. E., **The Lotmar-Picken x-ray diagram of dried muscle,** *Nature* **169**, 120 (1952) (Letter to the Editor).

424. Bernal, J. D., **Phase determination in the x-ray diffraction patterns of complex crystals and its application to protein structure,** *Nature* **169**, 1007–8 (1952) (Letter to the Editor).

425. Blout, E. R., and Linsley, S. G., **Infrared spectra and the structure of glycine and leucine peptides,** *J. Am. Chem. Soc.* **74**, 1946–51 (1952).

426. Cochran, W., and Crick, F. H. C., **Evidence for the Pauling-Corey α-helix in synthetic polypeptides,** *Nature* **169**, 234–5 (1952) (Letter to the Editor).

427. Cochran, W., Crick, F. H. C., and Vand, V., **The structure of synthetic polypeptides: I: The transforms of atoms on a helix,** *Acta Cryst.* **5**, 581–6 (1952) (in English).

428. Crick, F. H. C., **Is α-keratin a coiled coil?** *Nature* **170**, 882–3 (1952) (Letter to the Editor).

429. Donohue, J., **The hydrogen bond in organic crystals,** *J. Phys. Chem.* **56**, 502–10 (1952).

430. Elliott, A., **The α-β transformation in stretched hair,** TEXTILE RESEARCH JOURNAL **22**, 783–6 (1952).

431. Elliott, A., **The hydrogen bond in an amide link,** *J. Chem. Phys.* **20**, 756 (1952) (Letter to the Editor).

432. Fraser, R. D. B., and Price, W. C., **Infra-red dichroism and protein structure,** *Nature* **170**, 490–1 (1952).

433. Hosemann, R., **Determination of the statistical structure parameters of micelle lattices of fibrous materials of high molecular weight,*** *Kolloid-Z.* **125**, 149–56 (1952).

434. Hosemann, R., **The paracrystalline fine structure of natural and synthetic proteins: A visual approximation method for the determination of deviation tensors of unit cells,** *Acta Cryst.* **4**, 520–30 (1951) (in English).

435. Huxley, H. E., and Kendrew, J. C., **Extractability of the Lotmar-Picken material from dried muscle,** *Nature* **170**, 882 (1952) (Letter to the Editor).

436. Katz, L., Pasternak, R. A., and Corey, R. B., **Configuration of the peptide link and of asparagine in glycyl-*L*-asparagine,** *Nature* **170**, 1066 (1952) (Letter to the Editor).

437. Kratky, O., **New equatorial small-angle reflections of *beta*-keratin,*** *Z. Naturforsch.* **6b**, 173 (1951).

438. Lang, J. M., and Lucas, C. C., **The analysis of hair keratin: I: Application of microbiological techniques to hydrolysates of human hair,** *Biochem. J.* **52**, 84–7 (1952).

439. Mercer, E. H., **The biosynthesis of fibers,** *Sci. Monthly* **75**, 280–7 (1952).

440. Mercer, E. H., **The supercontraction of keratin,** TEXTILE RESEARCH JOURNAL **22**, 476–9 (1952).

441. Middlebrook, W. R., **The chain weight of wool keratin,** *Biochim. et Biophys. Acta* **7**, 547–62 (1951) (in English).

442. Mizushima, S.-I., and Shimanouchi, T., **Structure of the polypeptide chain,*** *Kagaku no Ryôiki* (J. Japan. Chem.) **6**, 311 (1952) (*Chem. Abstracts* **46**, 6679e (1952)).

443. Mizushima, S.-I., Shimanouchi, T., Kuratani, K., Tsuboi, M., Sugita, T., Nakagawa, I., and Kurosaki, K., **Infra-red spectra of acetylproline *N*-methylamide and the configuration of a proline residue in a polypeptide chain,** *Nature* **169**, 1058–9 (1952) (Letter to the Editor).

444. Mizushima, S.-I., Shimanouchi, T., Tsuboi, M., Sugita, T., Kurosaki, K., Mataga, N., and Souda, R., **Near-infrared spectra of compounds with two peptide bonds and the configuration of a polypeptide chain: II,** *J. Am. Chem. Soc.* **74**, 4639–41 (1952).

445. Olofsson, B., **The molecular weight of wool-[proteins],*** *Medd. Svenska Textilforskningsinst.,* No. 14, 57–64 (1951) (*Chem. Abstracts* **46**, 2807f (1952)).

446. Pasynskiĭ, A. G., **Significance of dissimilarity of peptide bonds in protein molecules,*** *Doklady Akad. Nauk S.S.S.R.* **77**, 863–5 (1951) (*Chem. Abstracts* **46**, 809g (1952)).

447. Pauling, L., and Corey, R. B., **Configurations of polypeptide chains with equivalent *cis*-planar groups,** *Proc. Natl. Acad. Sci. U. S.* **38**, 86–93 (1952).

448. Pauling, L., and Corey, R. B., **Configurations of polypeptide chains with favored orientations around single bonds: two new pleated sheets,** *Proc. Natl. Acad. Sci., U. S.* **37**, 729–40 (1951).

449. Pauling, L., and Corey, R. B., **The Lotmar-Picken x-ray diagram of dried muscle,** *Nature* **169**, 494–5 (1952) (Letter to the Editor).
450. Robinson, C., and Ambrose, E. J., **Atomic models: II: The use of atomic models in investigating stable configurations of protein chains,** *Trans. Faraday Soc.* **48**, 854–69 + 4 plates (1952).
451. Steele, R., **Recent developments in the structure of keratin fibers,** *J. Soc. Cosmetic Chemists* **3**, 99–107 (1952).
452. Ward, W. H., **The molecular size of proteins from several wools solubilized in aqueous urea,** TEXTILE RESEARCH JOURNAL **22**, 405–15 (1952).
453. Woods, E. F., **The viscosity of urea solutions of keratin,** *Australian J. Sci. Research* **5A**, 555–62 (1952).
454. Wrinch, D., **Skeletal units in protein crystals,** *Science* **115**, 356–7 (1952).
455. Yakel, H. L., Jr., Pauling, L., and Corey, R. B., **Structure of the synthetic polypeptide poly-γ-methyl-*L*-glutamate,** *Nature* **169**, 920 (1952) (Letter to the Editor).
456. Zahn, H., **The fine structure of some proteins,*** *Angew. Chem.* **64**, 295–308 (1952) (*Chem. Abstracts* **46**, 8159d (1952)).

4. *Chemical Reactions*

457. Alexander, P., Carter, D., and Johnson, K. G., **Formation by formaldehyde of a cross-link between lysine and tyrosine residues in wool,** *Biochem. J.* **48**, 435–41 (1951).
458. Bell, J. W., and Whewell, C. S., **A note on the action of nickelammonium hydroxide on proteins in general,** *J. Soc. Dyers and Colourists* **68**, 305 (1952).
459. Bell, J. W., and Whewell, C. S., **The reaction between wool and nickelammonium hydroxide: I: The adsorption of nickel by wool from solutions of nickelammonium hydroxide,** *J. Soc. Dyers and Colourists* **68**, 299–305 (1952).
460. Biserte, G., and Pigache, P., **Controlled hydrolysis of wool: I: Influence of pH on the nature of the fractions liberated,*** *Bull. soc. chim. biol.* **33**, 1379–90 (1951).
461. Block, R. J., **Chemical classification of keratins,** *J. Soc. Cosmetic Chemists* **2**, 235–9 (1951) (*Chem. Abstracts* **46**, 1079a (1952)).
462. Fearnley, C., and Speakman, J. B., **The action of β-propiolactone on wool,** *J. Soc. Dyers and Colourists* **68**, 88–91 (1952).
463. Fröhlich, H. G., **The reaction of peracetic acid with rabbit hair,*** *Z. ges. Textil-Ind.* **54**, 27–8, 30–2 (1952).
464. Fromageot, C., Justisz, M., Meyer, D., and Pénasse, L., **A method for characterizing the terminal carboxyl groups of proteins: Application to insulin,*** *Compt. rend.* **230**, 1905–6 (1950).
465. Hanna, B. L., **Production of pigments similar to those from hair from amino acid and keratin interaction,** *Proc. Soc. Exptl. Biol. Med.* **80**, 285–7 (1952).
466. Lennox, F. G., **Digestion of wool keratin by papain-bisulfite-urea and related systems,** *Australian J. Sci. Research* **B5**, 189–209 (1952).
467. McKay, R., **Reactions of keratin in alkaline solutions,** *J. Soc. Leather Trades' Chemists* **35**, 382–8 (1951).
468. Meybeck, J., and Schirlé, C., **The adaptation of classical chromatographic methods to the separation of the amino-acids of wool treated with hypochlorous acid,*** *Bull. inst. text. France*, No. 30, 343–9 + 2 pp. figures (1952).
469. Mishin, V. P., and Garbuzov, A. I., **Thermography of protein substances,*** *Biokhimiya* **16**, 416–19 (1951) (*Chem. Abstracts* **46**, 2103a (1952)).
470. Oku, M., and Sakaguchi, I., **Crimping crimpless keratinous fibers: I: Crimping angora rabbit hair by fuming nitric acid vapor,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 73–4 (1952) (*Chem. Abstracts* **46**, 8859f (1952)).
471. Oku, M., and Sakaguchi, I., **Crimping crimpless keratinous fibers: II: Crimping angora rabbit hair by neutral salt solutions,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 224–6 (1952) (*Chem. Abstracts* **46**, 8859g (1952)).
472. Park, G. S., and Speakman, J. B., **Estimation of cystine and cysteine in keratin,*** *Bull. inst. text. France*, No. 30, 255–72 (1952).
473. Sakaguchi, I., and Oku, M., **Chemical modification of keratinous fibers: I: Factors relating to the action of sodium thioglycolate on wool keratin,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 226–8 (1952) (*Chem. Abstracts* **46**, 8861h (1952)).
474. Sakaguchi, I., and Oku, M., **Chemical modification of keratinous fibers: II: Action of enzymes on the fibers pretreated with sodium thioglycolate,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 285–7 (1952) (*Chem. Abstracts* **46**, 8861i (1952)).
475. Schöberl, A., **Green hairs: A contribution to the problem of metal deposition in wool fibers,*** *Melliand Textilber.* **33**, 4–14 (1952).
476. Shikanova, I. A., **Reaction involved in the modification of wool keratin,*** *Zhur. Priklad. Khim.* **6**, 667–72 (1950) (*Chem. Abstracts* **46**, 5849g (1952)).
477. Speakman, J. B., **New research on the chemistry of wool,*** *Melliand Textilber.* **33**, 823–8 (1952).
478. Speakman, J. B., and Menkart, J., **The dissolution of keratin,*** *Bull. inst. text. France*, No. 30, 315–23 (1952).
479. Sullivan, M. X., and Folk, J. E., **A new procedure for the quantitative splitting of lanthionine to cysteine,** *Arch. Biochem. and Biophys.* **35**, 305–10 (1952).
480. Whewell, C. S., and Woods, H. J., **The action of metal amines on wool,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 103–17 (in English).

See also [141, 489]

5. *Mechanical Properties*

481. Asquith, R. S., and Speakman, J. B., **Chemical mechanism of permanent set,** *Nature* **170**, 798–9 (1952) (Letter to the Editor).
482. Azuma, N., and Aoki, M., **The cohesive set of wool,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 31–3 (1950) (*Chem. Abstracts* **46**, 4238f (1952)).
483. Dry, F. W., Burley, R. W., and Speakman, J. B., **Plasticity of wool,** *Nature* **169**, 371–2 (1952) (Letter to the Editor).
484. Errera, J., **Elastic properties of animal fibers and consequences of this elasticity from the point of view of the textile industry,*** *Bull. inst. text. France*, No. 30, 351–64 (1952).

PROTEIN FIBERS

485. Fearnley, C., and Speakman, J. B., **The swelling of keratin,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 155–64 (in English).
486. Fuhrmann, W., **Elongation mechanism of hair,*** *Melliand Textilber.* **33**, 911–15 (1952).
487. Hambraeus, E., and Steele, R., **The effect of lithium bromide solutions on the structure of keratin fibers,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 119–27 (in English).
488. Hill, T. L., **Some statistical mechanical models of elastic polyelectrolytes and proteins,** *J. Chem. Phys.* **20**, 1259–73 (1952).
489. Kubu, E. T., and Montgomery, D. J., **The stress relaxation of fibrous materials: II: Kinetics of the reduction of wool keratin by cysteine,** TEXTILE RESEARCH JOURNAL **22**, 778–82 (1952).
490. Lincoln, B., **Flexural fatigue and visco-elastic properties of wool fibres,** *J. Text. Inst.* **43**, T158–72 (1952).
491. Meyer, K. H., van der Wyk, A. J. A., Gonon, W., and Haselbach, C., **The long range elasticity of hair keratin,** *Trans. Faraday Soc.* **48**, 669–74 (1952).
492. Miyake, A., **Elasticity of keratin,*** *Busseiron Kenkyû* (Researches on Chem. Phys.), No. 30, 63–76 (1950) (*Chem. Abstracts* **46**, 4889a (1952)).
493. Miyake, A., **Mechanical properties of keratin,*** *Busseiron Kenkyû* (Researches on Chem. Phys.), No. 39, 121–30 (1951) (*Chem. Abstracts* **46**, 4889c (1952)).
494. Miyake, A., **A statistical [mechanical] theory of wool-like elasticity,*** *Busseiron Kenkyû* (Researches on Chem. Phys.), No. 47, 79–84 (1952) (*Chem. Abstracts* **46**, 4889e (1952)).
495. Oku, M., and Sakaguchi, I., **Physical and chemical properties of Angora rabbit hair,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 129–31 (1950) (*Chem. Abstracts* **46**, 4805f (1952)).
496. Reumuth, H., **The stretching and tearing process in wool,*** *Melliand Textilber.* **33**, 41–4 (1952).
497. Schwab, R., **Investigations on the physical properties of wool,*** *Melliand Textilber.* **33**, 962–4 (1952).
498. Sikorski, J., **Reversal of the molecular set in keratin,** *Nature* **170**, 275–6 (1952).
499. Sikorski, J., and Woods, H. J., **The effect of rate of extension on the Young's modulus of keratin fibres,** *Proc. Leeds Phil. Lit. Soc., Sci. Sect.* **5**, 313–17 (1950).
500. Weclawowicz, M., **Variability of the breaking length of Merino wool,*** *Prace Glównego Inst. Wlókiennictwa* **1**, 49–61 (1952) (*Faserforsch. u. Textiltech.* **3**, 292 (1952)).
501. van Wyk, C. M., **The effect of absorbed water on the dynamic bending modulus of animal fibres,** *S. African J. Sci.* **47**, 127–32 (Nov. 1951) (*J. Text. Inst.* **43**, A114 (1952)).

See also [1088, 1090]

6. Absorption and Swelling

502. King, G., and Warburton, F. L., **The saturation moisture absorption of wool,** *J. Text. Inst.* **43**, T516–17 (1952) (Letter to the Editor).
503. Miyake, A., **Dielectric constant and sorption property of high polymers,*** *Busseiron Kenkyû* (Researches on Chem. Phys.), **48**, 1–10 (1952) (*Chem. Abstracts* **46**, 5384e (1952)).
504. Olofsson, B., **Combination of wool with acids,** *J. Soc. Dyers and Colourists* **68**, 506–10 (1952).
505. Ripa, O., and Speakman, J. B., **The influence of stress on the swelling of animal fibres,** *J. Text. Inst.* **43**, T517–18 (1952) (Letter to the Editor).
506. Stam, P. B., Kratz, R. F., and White, H. J., Jr., **The swelling of human hair in water and water vapor,** TEXTILE RESEARCH JOURNAL **22**, 448–65 (1952).
507. Treloar, L. R. G., **The absorption of water by hair, and its dependence on applied stress,** *Trans. Faraday Soc.* **48**, 567–76 (1952).
508. Weir, C. E., **Effect of moisture on compressibility of natural high polymers,** *J. Research Natl. Bur. Standards* **49**, 135–9 (1952).

See also [249, 501, 584, 807, 1676, 1679, 1682, 1684, 1685, 1688]

7. Damage

509. Farnworth, A. J., **Chemical changes occurring in wool during wet processing,** *Text. J. Australia* **27**, 223–7 (1952).
510. Hirsch, F., **The effect of nitrous acid on wool,*** *Melliand Textilber.* **33**, 941–3 (1952).
511. Kehren, M., **Wool damage and its prevention,*** *Z. ges. Textil-Ind.* **54**, 23–7 (1952).
512. Kehren, M., and Lemcke, M., **Wool damage; its cause, detection, and hindrance: II,*** *SVF Fachorgan Textilveredl.* **7**, 225–8 (1952) (*Chem. Abstracts* **47**, 324a (1953)).
513. Kidd, F., and Whewell, C. S., **Measurement of damage in coarse keratinous materials,** *J. Soc. Dyers and Colourists* **68**, 396 (1952) (Letter to the Editor).
514. van Kuyeren, N., **Identification of wool damaged by singeing,*** *Textil-Praxis* **7**, 41–2 (1952).
515. Laxer, G., and Whewell, C. S., **The measurement of damage produced by treatment of wool with solutions of hydrogen peroxide,** *J. Soc. Dyers and Colourists* **68**, 256–7 (1952) (Letter to the Editor).
516. Lees, K., and Elsworth, F. F., **A study of the alkali solubility test for determining the degree of fibre damage in wool,** *J. Soc. Dyers and Colourists* **68**, 207–13 (1952).
517. O'Reilly, D. F., Whitwell, J. C., Steele, R. O., and Wakelin, J. H., **Properties of apparel wools: II: Modification of fiber surface during worsted processing,** TEXTILE RESEARCH JOURNAL **22**, 441–7 (1952).
518. van Overbeke, M., Mazingue, G., and Desprets, P., **Thermal degradation of wool,*** *Bull. inst. text. France,* No. 30, 273–88 + 2 pp. figures (1952).
519. van Overbeke, M., Mazingue, G., and Outreman, P., **Contribution to the study of tests for deterioration of wool,*** *Bull. inst. text. France,* No. 34, 53–70 (1952).
520. Robinet, M., **Determination and measurement of the modification of wool,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 91–102 (in French).
521. Rzegocinski, M. Z. ,and Lund, R., **The time of recovery from supercontraction as an indication of the degree of damage in wool fibres: A suggested new test,** *J. Text. Inst.* **43**, T91–102 (1952).
522. Weber R., **Chemical identification of wool damage,*** *SVF Fachorgan Textilveredl.* **7**, 15–20, 55–9 (1952) (*Chem. Abstracts* **46**, 5323d (1952)).
523. Weyrich, P., **Damaging wool through the dyeing process,*** *Textil-Praxis* **7**, 463–4 (1952).

See also [469, 977–990, 1185, 1186, 1320, 1713]

8. Wool Wax

524. Barnes, C. S., Barton, D. H. R., Cole, A. R. H., Fawcett, J. S., and Thomas, B. R., **The constitution of lanosterol,** *Chemistry & Industry* **1952**, 426.
525. Barnes, C. S., Curtis, R. G., and Hatt, H. H., **Studies in waxes: IV: The saponification of wool wax and the recovery of the wax alcohols,** *Australian J. Applied Sci.* **3**, 88–99 (1952).
526. Birchenough, M. J., and Burton, H., **Pyridinium sulfates derived from cholesterol and lanostadienol,** *J. Chem. Soc.* **1952**, 2443–4.
527. Curtis, R. G., Fridrichsons, J., and Mathieson, A. M., **Structure of lanostenol,** *Nature* **170**, 321–2 (1952) (Letter to the Editor).
528. Curtis, R. G., and Silberman, H., **The degradation of the side chain of lanostadienol,** *J. Chem. Soc.* **1952**, 1187–8.
529. Gieser, F., **Wool wax,*** *Fette u. Seifen* **54**, 92–5 (1952) (*Chem. Abstracts* **46**, 7345g (1952)).
530. Horner, J. L., and Truter, E. V., **The hydrolysis of wool wax and related high molecular weight esters: III: Heterogeneous reaction: Water-in-oil emulsions,** *J. Applied Chem.* (London) **1**, Suppl. Issue No. 2, S81–5 (1951).
531. Murray, K. E., and Schoenfeld, R., **Studies in waxes: V: The aliphatic alcohols of wool wax,** *J. Am. Oil Chemists' Soc.* **29**, 416–20 (1952).
532. Nunn, J. R., **Wool wax: I: Synthesis of some anteiso-acids,** *J. Chem. Soc.* **1951**, 1740–4.
533. Rossouw, S. D., and von Rudloff, E., **Wool wax: II: Lime saponification,** *J. Applied Chem.* **2**, 335–8 (1952).
534. Tiedt, J., and Truter, E. V., **The constitution of some wool wax esters,** *Chemistry & Industry* **1952**, 403.
535. Truter, E. V., **The constitution of wool wax,** *Quart. Revs.* (London) **5**, 390–404 (1951).

See also [1444]

B. Silk

1. Biosynthesis and Structure

536. Bradfield, J. R. G., **Phosphatases and nucleic acids in silk glands: Cyto-chemical aspects of fibrillar protein secretion,** *Quart. J. Microscop. Sci.* **92**, 87–112 (1951).
537. Denucé, J. M., **The phosphatases of the silk glands of the silk worm, *Bombyx mori*,*** *Experientia* **8**, 64–5 (1952) (in French).
538. Holmes, F. H., and Smith, D. I., **Sedimentation and diffusion of soluble fibroin,** *Nature* **169**, 193 (1952) (Letter to the Editor).
539. Kratky, O., and Schauenstein, E., **X-ray and ultra-violet spectrographic investigations of fibrous and globular modifications of silk fibroin,** *Discussions Faraday Soc.* **1951**, No. 11, 171–8.
540. Kratky, O., Schauenstein, E., and Sekora, A., **Relations between small-angle interferences of silk and the wax content,** *Nature* **170**, 796–7 (1952) (Letter to the Editor).
541. Mercer, E. H., **The fine structure and biosynthesis of silk fibroin,** *Australian J. Sci. Research* **B5**, 366–73 (1952).
542. Okamoto, S., **Distribution of amino acids in silk fibroin: I: Acid hydrolysis,*** *J. Soc. Textile Cellulose Ind.* **7**, 445–8 (1951) (*Chem. Abstracts* **46**, 4040a (1952)).
543. Pinte, J., **The structure of silk and the causes and mechanism of its deterioration,*** *Teintex* **17**, 607–8, 611, 613–14, 617, 619–20, 623, 625–6 (1952).
544. Satô, Y., **General theory of elasticity of chain molecules: II: Molecular configuration and large elasticity of liquid silk,*** *Busseiron Kenkyû* (Researches on Chem. Phys.), No. 47, 6–17 (1952) (*Chem. Abstracts* **46**, 4887i (1952)).
545. Shimura, K., Koide, F., Itabashi, H., and Fukai, H., **Protein synthesis in excised silk glands,*** *Symposia on Enzyme Chem.* (Japan) **7**, 51–3 (1952) (*Chem. Abstracts* **46**, 9636f (1952)).
546. Sobue, H., and Konishi, H., **Protein fiber: I: Acid hydrolysis and microstructure of silk fibroin,*** *J. Chem. Soc. Japan,* Ind. Chem. Sect., **53**, 168–70 (1950) (*Chem. Abstracts* **46**, 10225d (1952)).
547. Toms, B. A., and Elliott, A., **Determination of the configuration of silk fibroin dissolved in aqueous solutions of lithium bromide,** *Nature* **169**, 877–8 (1952) (Letter to the Editor).
548. Zahn, H., **The fine structure and chemistry of silk,*** *Melliand Textilber.* **33**, 1076–84 (1952).

See also [416, 439]

2. Chemical Reactions

549. Bryant, F., **Chromatographic studies of the silk fiber: II: Fractionation of a fibroin hydrolyzate,** TEXTILE RESEARCH JOURNAL **22**, 525–8 (1952).
550. Elliott, D. F., **A search for specific chemical methods for fission of peptide bonds: I: The *N*-acyl to *O*-acyl transformation in the degradation of silk fibroin,** *Biochem. J.* **50**, 542–50 (1952).
551. Elliott, D. F., **Selective fission of the silk fibroin molecule following *N*→*O* acyl migration,** *Chemistry & Industry* **1952**, 86 (Letter to the Editor).
552. Glanzmann, R., and Signer, R., **The amino-acid composition of silk fibroin and silk fibroin fractions,*** *Makromol. Chem.* **8**, 134–9 (1952).
553. Happey, F., and Hyde, A. J., **Composition of silk,** *Nature* **169**, 921 (1952) (Letter to the Editor).
554. Korchagin, M. V., **Action of alkalies and acids on silk fibroin in the presence of neutral salts,*** *Zhur. Priklad. Khim.* **25**, 212–16 (1952) (*Chem. Abstracts* **46**, 6393c (1952)).
555. Murase, R., and Sakaguchi, S., **Physicochemical studies on silk: VII: Microstructure of wild silk fibroin,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 97–101 (1951) (*Chem. Abstracts* **46**, 3764i (1952)).
556. Okamoto, S., **Distribution of amino acids in silk fibroin: II: Distribution of hydroxyamino acids in fibroin,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 85–7 (1952) (*Chem. Abstracts* **46**, 8695e (1952)).
557. Okamoto, S., **Distribution of amino acids in silk fibroin: III: Regional distribution of serine and other main amino acids,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 448–51 (1952) (*Chem. Abstracts* **47**, 162c (1953)).
558. Oku, M., and Koide, N., **Chemical structure of silk fibroin: II: Decomposition by chromic acid,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 335–8 (1949) (*Chem. Abstracts* **46**, 4237i (1952)).
559. Sakurada, I., and Noma, K., **Coupling of silk fibroin with diazonium salt,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 251–3 (1950) (*Chem. Abstracts* **46**, 4238a (1952)).
560. Schauenstein, E., **The ultra-violet absorption of silk fibroin: I,*** *Melliand Textilber.* **33**, 591–7 (1952).

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561. Takahashi, G., Noma, K., and Sakurada, I., **Coupling of *L*-tyrosine and silk fibroin with diazonium salts,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 218–21 (1951) (*Chem. Abstracts* **46**, 4238b (1952)).

562. Tsintsevich, E. P., and Botvinik, M. M., **Amino acids in the silk fibroin of the mulberry and oak silkworms,*** *Zhur. Priklad. Khim.* **23**, 750–3 (1950) (*Chem. Abstracts* **46**, 5623g (1952)).

563. Zahn, H., and Würz, A., **Reaction of silk fibroin with 2,4-dinitrofluorobenzene,*** *Biochem. Z.* **322**, 327–39 (1952).

See also [548]

3. *Mechanical Properties*

564. Murase, R., **Physicochemical studies on silk: I: Relation between the amount of crystalline part and the physicochemical properties,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 217–19 (1949) (*Chem. Abstracts* **46**, 3764e (1952)).

565. Murase, R., **Physicochemical studies on silk: III: Role of tyrosine in the salt contraction,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 334–7 (1950) (*Chem. Abstracts* **46**, 3764g (1952)).

566. Murase, R., **Physicochemical studies on silk: IV: Mechanical properties of salt-contracted silk,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 337–40 (1950) (*Chem. Abstracts* **46**, 3764g (1952)).

567. Murase, R., **Physicochemical studies on silk: V: Salt contraction of nitrated silk fibroin,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 385–7 (1950) (*Chem. Abstracts* **46**, 3764h (1952)).

568. Murase, R., and Sakaguchi, S., **Physicochemical studies on silk: II: Salt-contraction process of silk,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 362–4 (1949) (*Chem. Abstracts* **46**, 3764f (1952)).

569. Murase, R., and Sakaguchi, S., **Physicochemical studies on silk: VI: Control of the salt contraction by diazotization,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 457–60 (1950) (*Chem. Abstracts* **46**, 3764h (1952)).

570. Murase, R. and Sakaguchi, S., **Physicochemical studies on silk: VIII: Relation between the decomposition of silk fibroin by strong oxidizing agents and the salt contraction,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 497–500 (1951) (*Chem. Abstracts* **46**, 3765a (1952)).

571. Negishi, M., and Funakoshi, R., **Effects of stretching on silk-fibroin fibers: II: Low stretching in water,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 26–9 (1951) (*Chem. Abstracts* **46**, 6389i (1952)).

572. Negishi, M., and Funakoshi, R., **Effects of stretching on silk-fibroin fibers: III: Some characteristics of low stretching,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 101–3 (1951) (*Chem. Abstracts* **46**, 6390a (1952)).

573. Negishi, M., and Funakoshi, R., **Effects of stretching on silk-fibroin fibers: IV: Influence of water on the heating effect,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 552–4 (1951) (*Chem. Abstracts* **46**, 6390a (1952)).

574. Negishi, M., and Funakoshi, R., **Effects of stretching on silk-fibroin fibers: V: Stabilizing temperature and stretching,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 554–7 (1951) (*Chem. Abstracts* **46**, 6390b (1952)).

575. Tsuji, W., and Kitamaru, R., **Improvement of fiber quality with synthetic resin treatment: I: Polymerization of vinyl acetate in silk,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 261–4 (1950) (*Chem. Abstracts* **46**, 6390c (1952)).

See also [247]

4. *Sericin*

576. Bryant, F., **Chromatographic studies of the silk fiber: I: The amino acid composition of two sericin fractions,** TEXTILE RESEARCH JOURNAL **22**, 523–5 (1952).

577. Bryant, F., **Determination of the fat content of silk soaking emulsions,** TEXTILE RESEARCH JOURNAL **22**, 433–4 (1952) (Letter to the Editor).

578. Krestinskaia, V. N., and Aĭmukhamedova, M. B., **Chemical composition of the stabilizer of sericin,*** *Zhur. Priklad. Khim.* **25**, 197–204 (1952) (*Chem. Abstracts* **46**, 9638g (1952)).

579. Krestinskaia, V. N., and Aĭmukhamedova, M. B., **Removal of sericin from raw silk with solutions containing products of sericin hydrolysis,*** *Zhur. Priklad. Khim.* **24**, 634–9 (1951) (*Chem. Abstracts* **46**, 7133b (1952)).

580. Krestinskaia, V. N., and Aĭmukhamedova, M. B., **The role of amino acids in the solution which removes sericin from raw silk,*** *Zhur. Priklad. Khim.* **24**, 1298–1305 (1951) (*Chem. Abstracts* **46**, 4238c (1952)).

581. Müller, W., **Special methods of degumming silk,** *Ciba Rev.* (American Ed.), No. 91, 3290–1 (1952).

582. Tateishi, A., and Narita, T., **Practical properties of plain silk,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 155–8 (1949) (*Chem. Abstracts* **46**, 3284h (1952)).

5. *Miscellaneous*

583. Green, R. W., **The reaction of hydrogen chloride with dry proteins: II: Collagen, silk fibroin, elastin,** *Trans. Proc. Roy. Soc. New Zealand* **79**, 485–93 (1952).

584. Green, R. W., **The reaction of hydrogen chloride with dry proteins: III: The adsorption of water vapor on hydrochlorides of collagen and of silk fibroin,** *Trans. Proc. Roy. Soc. New Zealand* **79**, 494–504 (1952).

585. Ishikawa, H., and Okuda, T., **Drying of silk cocoons with high frequency waves,*** *J. Soc. Org. Synthet. Chem.* (Japan) **7**, 182–91 (1949) (*Chem. Abstracts* **47**, 323i (1953)).

586. Kabai, H., **Water-resisting properties of the domestic cocoon shell: II: Mechanism of the relation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 359–61 (1949) (*Chem. Abstracts* **46**, 5214i (1952)).

587. Kabai, H., and Fujio, T., **Water-resisting properties of the domestic cocoon shell: I: Relation between the water content and water absorption and the effect of waterproofing treatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 356–9 (1949) (*Chem. Abstracts* **46**, 5214h (1952)).

588. Kabai, H., and Kawakita, J., **Water-resisting properties of the domestic cocoon shell: III: Wettability of cocoon shells in contact with water,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 82–5 (1950) (*Chem. Abstracts* **46**, 5215a (1952)).

589. Kanamaru, K., and Aragaki, M., **Lyotropic series indicated by the swelling effect of ions on silk fibroin,*** *J. Chem. Soc. Japan,* Ind. Chem. Sect., **53**, 261–3 (1950) (*Chem. Abstracts* **46**, 10225e (1952)).

590. Marshall, P. A., and Moore, W. J., **Sorption of ammonia by silk fibroin,** *J. Am. Chem. Soc.* **74**, 4779–83 (1952).
591. Nishida, K., **Effects of metallic salts in dyeing silk: I: Absorption affected in direct dyeing,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 404–6 (1952) (*Chem. Abstracts* **47**, 321i (1953)).
592. Schenk, A., and Fraisse, R., **Diameter variations of the filaments of the principal French types of *Bombyx-Mori* (L) cocoons,*** *Bull. inst. text. France*, No. 33, 21–32 + 1 plate (1952).
593. Vaterlaus, K., **Dyeing blacks on silk,*** *SVF Fachorgan Textilveredl.* **6**, 134–6, 165–9 (1951) (*J. Text. Inst.* **43**, A243 (1952)).

C. Regenerated Protein Fibers

594. Alexander, P., **Regenerated protein fibres from keratin,** *Textile Inds. and Fibres* **13**, 254–7, 286–9 (1952).
595. Alexander, P., Carter, D., Earland, C., and Mariner, P. F., **An artificial fiber from wool in the α-configuration,*** *Melliand Textilber.* **33**, 187–8 (1952).
596. Arthur, J. C., Jr., and Many, H. G., **Peanut protein fiber—Flow characteristics of spinning solutions as affected by rate of extrusion,** *Am. Dyestuff Reptr.* **41**, 385–6 (1952).
597. Coppa-Zuccari, G., **A new protein fiber from hides,** *Rayon and Synthetic Texts.* **32**, No. 5, 44, 63 (1952).
598. Genin, G., **Stabilization of casein fibers by deamination,*** *Lait* **31**, 92–100 (1951) (*Chem. Abstracts* **46**, 10224h (1952)).
599. Haworth, R. D., MacGillivray, R., and Peacock, D. H., **The action of formaldehyde on proteins: III: The hydrolysis of formaldehyde-hardened proteins by enzymes,** *J. Chem. Soc.* **1952**, 2981–7.
600. Haworth, R. D., Peacock, D. H., Smith, W. R., and MacGillivray, R., **The action of formaldehyde on proteins: II: Some reactions of *N*-hydroxymethylamides,** *J. Chem. Soc.* **1952**, 2972–80.
601. Koch, P.-A., **Fiber tables: Peanut protein fiber: Ardil,*** *Textil-Rundschau* **7**, 118–21 (1952).
602. Komuro, T., Togami, E., and Futami, A., **Treatment of casein and its fibers with formaldehyde,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 512–15 (1950) (*Chem. Abstracts* **46**, 4803a (1952)).
603. Laird, E. R., **Dielectric properties of some solid proteins at wave lengths 1.7 meters and 3.2 centimeters,** *Can. J. Phys.* **30**, 663–9 (1952).
604. Somers, J. A., **Regenerated silk: Fibroin as a raw material for protein fibres,** *Brit. Rayon and Silk J.* **28**, No. 333, 62–4 (1952).
605. Thomson, R. H. K., **Ardil: Properties and uses,** *Textile Age* **16**, No. 6, 23–5 (1952).

See also [445, 688]

IV. SYNTHETIC FIBERS

A. General

606. Bunn, H., **Synthetic fiber production: Cost and availability of raw materials,** *Ind. Eng. Chem.* **44**, 2128–33 (1952).
607. Dillon, J. H., **Tensile properties of newer fibers,** *Ind. Eng. Chem.* **44**, 2115–22 (1952).
608. Goppel, J. M., **Fibrous materials from the physical point of view,** in **"Symposium on the Physics of Fibrous Materials"** (collected papers), Arnhem, Holland, 1950, pp. 13–36.
609. Grabe, F., **The synthetic fibers and their chemical-technical utilization,*** *Chem.-Ztg.* **76**, 436–8 (1952).
610. Heckert, W. W., **Selection of fiber monomers,** *Ind. Eng. Chem.* **44**, 2103–9 (1952).
611. Hoyer, C. O., **Synthetic fiber production: Choice of plant sites,** *Ind. Eng. Chem.* **44**, 2133–7 (1952).
612. Loasby, G., **A history of rayon and the synthetic fibres,** *Research* **5**, 16–23 (1952).
613. Mark, H., **Influence of molecular structure on properties,** *Ind. Eng. Chem.* **44**, 2110–14 (1952).
614. Parisot, A., and Cannepin, A., **Contribution of the synthesis of man-made fibers to the knowledge of natural fibers,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 227–38 (in French).
615. Reynolds, R. J. W., **Fiber-forming polymers,** *Plastics Inst.* (London) *Trans.* **20**, No. 42, 81–93 (1952) (*Chem. Abstracts* **47**, 1973h (1953)).
616. Somers, J. A., **The search for new polymers: Dye affinity and tensile strength,** *Brit. Rayon and Silk J.* **29**, No. 338, 51–2 (1952).

See also [801, 1088]

B. Polycondensation Polymers

1. Polyamide Fibers

(a) Polyhexamethyleneadipamide

617. Allen, P. W., **The kinetics of the crystallization of hexamethylene adipamide polymer (6.6 nylon),** *Trans. Faraday Soc.* **48**, 1178–85 (1952).
618. Bjørnhaug, A., Ellefsen, Ø., and Tønnesen, B. A., **Interpretation of x-ray diagrams of unoriented organic chain polymer substances: I: Polyhexamethylene adipamide (nylon-6, 6),** *Norsk Skogind.* **6**, 243–9 (1952) (in English) (*Bull. Inst. Paper Chem.* **23**, 135 (1952)).
619. Bunn, C. W., **Recent developments in x-ray diffraction studies of high polymers,** *J. Applied Chem.* **1**, 266–8 (1951).
620. Eyring, H., Alder, M. G., Rossmassler, S. A., and Christensen, C. J., **Forced vibrations of polyamide monofils,** TEXTILE RESEARCH JOURNAL **22**, 223–46 (1952).
621. Hasselstrom, T., Coles, H. W., Balmer, C. E., Hannigan, M., Keeler, M. M., and Brown, R. J., **The behavior of nylon oxford cloth "41" on pyrolysis,** TEXTILE RESEARCH JOURNAL **22**, 742–8 (1952).
622. Hünlich, R., **The properties of nylon,*** *Reyon Zellwolle u. Chemiefasern* **30**, 122–32 (1952).
623. Korshak, V. V., and Zamiatina, V. A., **On the degree of polydispersity of polyamides,*** *Doklady Akad. Nauk S.S.S.R.* **59**, 909–12 (1948) (*J. Text. Inst.* **43**, A62 (1952)).
624. Lassé, R., **Microscopic studies on polyamide fibers (nylon),*** *Textil-Rundschau* **7**, 353–9 (1952).
625. Makishima, K., **Mechanical behavior of high polymers: I: Stress-strain relationship in nylon,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 328–30 (1950) (*Chem. Abstracts* **46**, 4803c (1952)).
626. Okada, A., and Fuchino, K., **Dielectric studies on solid high polymers: II: Nylon,*** *Chem. High Polymers* (Japan) **7**, 340–5 (1950) (*Chem. Abstracts* **46**, 4803d (1952)).
627. Wall, F. T., and Swoboda, T. J., **Electrolytic interaction of nylon with aqueous solutions of sodium hydroxide,** *J. Phys. Chem.* **56**, 50–6 (1952).

See also [250, 637, 644, 1649]

SYNTHETIC FIBERS

(*b*) *Poly-ϵ-aminocaprolactam*

628. Ancel, R., **Some characteristics of Perlon,*** *Industrie textile* **69**, 135–6 (1952) (*Chem. Abstracts* **46**, 6393e (1952)).
629. Benninga, N., **The manufacture of Enkalon yarn and staple,** *Rayon Rev.* (special Enkalon issue), 36–41 (1952) (English edition).
630. Böhringer, H., **The most important physical properties of Perlon,*** *Faserforsch. u. Textiltech.* **3**, 381–90 (1952).
631. Chrczonowicz, S., and Dyniewski, S., **Catalytic polymerization of caprolactam,*** *Prace Głównego Inst. Włókiennictwa*, No. 5, 1–8 (1952) (*Faserforsch. u. Textiltech.* **3**, 511 (1952)).
632. Fuchino, K., and Okada, N., **Dielectric studies on solid high polymers: I: ϵ and tan δ-temperature curves for polycaproamide,*** *Chem. High Polymers* (Japan) **6**, 497–501 (1949) (*Chem. Abstracts* **46**, 1316g (1952)).
633. Fuchino, K., and Ueno, S., **Young's modulus of polyamide fibers: II: Thermal stress of polycaproamide fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 494–7 (1951) (*Chem. Abstracts* **46**, 6391b (1952)).
634. van Hoek, P. C., **The use of nylon yarns in articles for industrial purposes,** *Rayon Rev.* (special Enkalon issue), 72–3 (1952) (English edition).
635. Hoshino, K., Mukoyama, E., and Watanabe, M., **Electrochemical studies on polyelectrolytes: II: Relation between the conductivity of molten polycaproamide and its number-average molecular weight,*** *Chem. High Polymers* (Japan) **7**, 322–7 (1950) (*Chem. Abstracts* **46**, 4323b (1952)).
636. Klare, H., **Critical considerations in the manufacture of Perlon,*** *Chem. Tech.* (Berlin), Beilage Kemststoff-Tech., **4**, 133–9 (1952) (*Chem. Abstracts* **46**, 9314h (1952)); *Textil- u. Faserstofftech.* **2**, 240–5 (1952) (*Faserforsch. u. Textiltech.* **3**, 463 (1952)).
637. Loepelmann, F., **Molecular weight and viscosity of polyamides (Perlon, nylon),*** *Faserforsch. u. Textiltech.* **3**, 58–66 (1952).
638. Meijberg, J. C., **Properties and uses of nylon yarn,** *Rayon Rev.* (special Enkalon issue), 44–7 (1952) (English edition).
639. Miagkov, V. A., and Pakshver, A. B., **Kinetics of hydrolysis of caprolactam and of polyamide resin,*** *Kolloid Zhur.* **14**, 172–6 (1952) (*Chem. Abstracts* **46**, 8484a (1952)).
640. Nagai, E., and Sagane, N., **Crystallization of polyamides by heating,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 165–7 (1952) (*Chem. Abstracts* **46**, 8860f (1952)).
641. Nagai, E., and Sagane, N., **Stress-temperature changes in polyamide fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 429–32 (1952) (*Chem. Abstracts* **47**, 325d (1953)).
642. Niks, A., **Caprolactam,** *Rayon Rev.* (special Enkalon issue), 30–5 (1952) (English edition).
643. Nowakowski, A., and Laczkowski, M., **Preliminary investigation of the reaction kinetics of the polycondensation of ϵ-aminocaproic acid,*** *Prace Głównego Inst. Włókiennictwa* **1**, 37–9 (1951) (*Faserforsch. u. Textiltech.* **3**, 290 (1952)).
644. Nuss, O., **The melt-spinning of Perlon and nylon,*** *Textil-Praxis* **7**, 570–3 (1952).
645. Ono, T., **Stretching properties of Amilan yarn after melt-spinning,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 428–9 (1952) (*Chem. Abstracts* **47**, 325h (1953)).
646. Roelofs, G., **Enkalon fibre,** *Rayon Rev.* (special Enkalon issue), 74–6 (1952) (English edition).
647. Schaefgen, J. R., and Trivisonno, C. F., **Polyelectrolyte behavior of polyamides: II: Viscosities of solutions of linear and multichain polyamides in formic acid,** *J. Am. Chem. Soc.* **74**, 2715–17 (1952).
648. Shpital'nyĭ, A. S., Meos, E. A., and Serkov, A., **Formation of polyamide resins,*** *Zhur. Obshchcĭ Khim.* **22**, 1266–70 (1952) (*Chem. Abstracts* **47**, 341f (1953)).
649. Tsuboi, M., **On the molecular state of water bound to the peptide linkage,** *Bull. Chem. Soc. Japan* **25**, 160–4 (1952) (in English).
650. Tsuruta, M., Nishio, M., and Hasegawa, K., **Viscosity of molten polycaproamide,*** *Chem. High Polymers* (Japan) **8**, 157–60 (1951) (*Chem. Abstracts* **47**, 372e (1953)).
651. Turska-Kusmierz, E., **Hydrolysis kinetics during the polymerization of caprolactam,*** *Prace Głównego Inst. Włókiennictwa*, No. 5, 115–32 (1952) (*Faserforsch. u. Textiltech.* **3**, 510 (1952)).
652. Turska-Kusmierz, E., **Investigations of the kinetics of the polymerization of caprolactam,*** *Przemysł Włókienniczy*, No. 11, 37–40 (1952) (*Faserforsch. u. Textiltech.* **3**, 338 (1952)).
653. Watanabe, M., **Crimps of Amilan,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 218–24 (1952) (*Chem. Abstracts* **46**, 8859g (1952)).
654. Wrieth, J., **Perlon fiber,*** *Textil-Rundschau* **7**, 323–6 (1952).

See also [703, 724]

(*c*) *Miscellaneous*

655. Ashar, K. G., and Champetier, G., **The polyamide formed by the polycondensation of 9,10-dihydroxy-1,18-octadecanedioic acid and 1,6-diaminohexane,*** *Compt. rend.* **234**, 1555–7 (1952).
656. Beste, L. F., and Houtz, R. C., **Amide interchange reactions,** *J. Polymer Sci.* **8**, 395–407 (1952).
657. Colonge, J., and Guyot, P., **Use of the continuous-weight method for the kinetic study of the polyamidification of amino acids,*** *Compt. rend.* **233**, 1604–6 (1951).
658. Kovacs, A., **On the cubic dilation of amorphous polyamides,*** *J. Polymer Sci.* **8**, 350–2 (1952) (Letter to the Editor) (in French).
659. Lewis, J. R., and Reynolds, R. J. W., ***N*-substitution in polyamides,** *Chemistry & Industry* **1951**, 958–61.
660. Lieser, T., **Nylon and nylonides,*** *Chem. Ztg.* **76**, 673–7 (1952).
661. Lincoln, B., **Frictional and elastic properties of high polymeric materials,** *Brit. J. Applied Phys.* **3**, 260–3 (1952).
662. Linde, V. V., and Rogovina, A. A., **Certain physicochemical properties of the polyamide fibers,*** *Tekstil. Prom.* **10**, No. 12, 22–5 (1950) (*Chem. Abstracts* **46**, 6390g (1952)).
663. Lum, F. G., and Carlston, E. F., **Isophthalic acid application in condensation polymers,** *Ind. Eng. Chem.* **44**, 1595–1600 (1952).

664. Mankash, E. K., and Pakshver, A. B., **Kinetics of heterogeneous hydrolysis of polyamide fibers in acid medium,*** *Zhur. Fiz. Khim.* **25**, 468–74 (1951) (*Chem. Abstracts* **46**, 5411d (1952)).

665. Okada, A., **Dielectric studies on solid high polymers: III: The copolymer of ε-caprolactam and nylon salt,*** *Chem. High Polymers* (Japan) **7**, 384–9 (1950) (*Chem. Abstracts* **46**, 6451b (1952)).

666. Pakshver, A. B., and Mankash, E., **Change of viscosity of polyamide fibers during heterogeneous hydrolysis in acid medium,*** *Kolloid Zhur.* **14**, 112–17 (1952) (*Chem. Abstracts* **46**, 7774e (1952)).

667. Pakshver, A. B., Mankash, E. K., and Kukonkova, A. I., **Extension and shrinkage of polyamide fibers in aqueous-phenolic solutions,*** *Textil. Prom.* **11**, No. 6, 15–16 (1951) (*J. Soc. Dyers and Colourists* **67**, 473 (1951)).

668. Shooter, K. V., and Tabor, D., **The frictional properties of plastics,** *Proc. Phys. Soc.* (London) **B65**, 661–71 (1952).

669. Vergoz, R., **The equilibrium constant for the formation of polyhendecanamide,*** *Compt. rend.* **233**, 619–21 (1951).

See also [141, 503, 774]

2. Polyester Fibers

670. Anon., **"Terylene": A progress report,** *Brit. Rayon and Silk J.* **29**, No. 342, 44–6, 48, 50, 52; No. 343, 55–6, 58–9 (1952); *Dyer* **108**, 537–9 (1952).

671. Edgar, O. B., **Structure-property relationships in polyethylene terephthalate copolyesters: II: Second-order transition temperatures,** *J. Chem. Soc.* **1952**, 2638–43.

672. Edgar, O. B., and Ellery, E., **Structure-property relationships in polyethylene terephthalate copolyesters: I: Melting points,** *J. Chem. Soc.* **1952**, 2633–8.

673. Edgar, O. B., and Hill, R., **The *p*-phenylene linkage in linear high polymers: Some structure-property relationships,** *J. Polymer Sci.* **8**, 1–22 (1952).

674. Izard, E. F., **Effect of chemical structure on physical properties of isomeric polyesters,** *J. Polymer Sci.* **9**, 35–9 (1952).

675. Keller, A., **Morphology of crystallizing polymers,** *Nature* **169**, 913–14 (1952).

676. Korshak, V. V., and Rogozhin, S. V., **High molecular weight compounds: 45: The significance of decarboxylation of dicarboxylic acids during polycondensation,*** *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk* **1952**, 531–9 (*Faserforsch. u. Textiltech.* **3**, 421 (1952)).

677. Korshak, V. V., and Soboleva, T. A., **High molecular weight compounds: 44: Polyesters of some aromatic dicarboxylic acids,*** *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk* **1952**, 526–30 (*Faserforsch. u. Textiltech.* **3**, 421 (1952)).

678. Korshak, V. V., and Vinogradova, S. V., **High molecular weight compounds: 41: Alcoholysis of polyesters,*** *Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk* **1951**, 756–60 (*J. Soc. Dyers and Colourists* **68**, 332 (1952)).

679. Lombard, F., **The structure and properties of the polyester of 11-hydroxyundecylic acid,*** *Bull. inst. text. France*, No. 30, 177–82 (1952); *Makromol. Chem.* **8**, 187–207 (1952).

680. Mandelkern, L., Garrett, R. R., and Flory, P. J., **Heats of fusion of aliphatic polyesters,** *J. Am. Chem. Soc.* **74**, 3949–51 (1952).

681. Mann, J., and Thompson, H. W., **Measurements with crystals using polarized infrared radiation,** *Proc. Roy. Soc.* (London) **A211**, 168–82 (1952).

682. Whinfield, J. R., **Fibres from aromatic polyesters,** *Endeavour* **11**, 29–32 (1952).

683. Wiloth, F., **Influence of chemical constitution on the molecular configuration in polyesters,*** *Makromol. Chem.* **8**, 111–23 (1952).

See also [619, 668, 703, 774]

3. Polyurethane Fiber

684. Borchert, W., **X-ray studies on organic fibers: Fine structure of polyurethan fiber, Perlon U,*** *Fortschr. Mineral.* **29/30**, 55–7 (1951).

685. Lieser, T., and Nischk, G., **Artificial organic high polymers: V: Linear polyureas and polyurethanes,*** *Ann.* **569**, 59–65 (1950).

686. Somers, J. A., **The search for new polymers: Fibres based on urea and thiourea,** *Brit. Rayon and Silk J.* **29**, No. 342, 56–8; No. 343, 62–3 (1952).

687. Zahn, H., and Winter, U., **The long period reflections in the x-ray diagram of polyurethane fibers,*** *Kolloid-Z.* **128**, 142–53 (1952).

C. Addition Polymers

1. Polyvinyl Fibers

(a) Polyvinylchloride

688. Foulon, A., **Rhovyl and Ardil,*** *Melliand Textilber.* **33**, 407–8 (1952).

689. Grabe, F., **Vinyl fibers,*** *Kunststoffe* **42**, 69–70 (1952).

690. Ikoma, I., Atsumi, M., and Kato, H., **Manufacture of polyvinyl chloride fibers: XIII: Stability in sunlight and against chemicals and the dyeing properties,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 329–31 (1952) (*Chem. Abstracts* **46**, 9852h (1952)).

691. Ikoma, I., Yurugi, T., and Kato, H., **Manufacture of polyvinyl chloride fibers: XII: Change of the mechanical properties with temperature,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 326–9 (1952) (*Chem. Abstracts* **46**, 9852f (1952)).

692. Ikoma, I., Yurugi, T., So, Y., Kato, H., Tsubakiyama, S., and Shiozawa, K., **Manufacture of polyvinyl chloride fibers: I: Solubility and the mechanism of polyvinyl chloride in a mixed solvent,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 394–7 (1951) (*Chem. Abstracts* **46**, 4272i (1952)).

693. Ikoma, I., Yurugi, T., So, Y., Kato, H., Tsubakiyama, S., and Shiozawa, K., **Manufacture of polyvinyl chloride fibers: II: Change of viscosity and coagulation,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 397–8 (1951) (*Chem. Abstracts* **46**, 4273a (1952)).

694. Ikoma, I., Yurugi, T., So, Y., Kato, H., Tsubakiyama, S., and Shiozawa, K., **Manufacture of polyvinyl chloride fibers: III: Relation between the viscosity and degree of polymerization,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 432–4 (1951) (*Chem. Abstracts* **46**, 4273b (1952)).

695. Ikoma, I., Yurugi, T., and Tsubakiyama, S., **Manufacture of polyvinyl chloride fibers: VIII: Effect of heating and its significance,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 167–9 (1952) (*Chem. Abstracts* **46**, 8860b (1952)).

SYNTHETIC FIBERS

696. Ikoma, I., Yurugi, T., and Tsubakiyama, S., **Manufacture of polyvinyl chloride fibers: IX: Hot-drawing limit and its effect,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 170–2 (1952) (*Chem. Abstracts* **46**, 8860b (1952)).

697. Ikoma, I., Yurugi, T., and Tsubakiyama, S., **Manufacture of polyvinyl chloride fibers: X: Transition in the heat-effect curve,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 268–9 (1952) (*Chem. Abstracts* **46**, 8860c (1952)).

698. Ikoma, I., Yurugi, T., and Tsubakiyama, S., **Manufacture of polyvinyl chloride fibers: XI: Change of the elastic properties by heat-softening,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 270–2 (1952) (*Chem. Abstracts* **46**, 8860e (1952)).

699. Mortureux, H., **Rhovyl,** *Rayonne et fibres synthét.* **7**, No. 7, 43–6 (1951).

700. Müller, F. H., **Further experiments and considerations on cold drawing,*** *Kolloid-Z.* **126**, 65–72 (1952).

See also [668]

(*b*) *Polyacrylonitrile*

701. Bendigo, C. W., **X-51 acrylic fiber: Spinning, weaving, knitting X-51,** *Papers AATT* **7**, 114–15 (1952).

702. Cresswell, A., **X-51 acrylic fiber: Physical and chemical properties,** *Am. Dyestuff Reptr.* **41**, 161–2 (1952); *Papers AATT* **7**, 111–13 (1952).

703. Edelmann, K., **The rheology of solutions of high polymers: III: Measurements of structural viscosity in solutions of the synthetic raw materials of man-made fibers,*** *Faserforsch. u. Textiltech.* **3**, 412–17 (1952).

704. Herrent, P., **Polydisperity of polyacrylonitrile,*** *J. Polymer Sci.* **8**, 346–9 (1952) (Letter to the Editor) (in French).

705. Holmes, D. F., **Orlon acrylic staple,** *Papers AATT* **7**, 85–96 (1952).

706. Mockel, J., **Contribution to the study of the viscoelastic properties of polyacrylonitrile fibers,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 129–40 (in French).

707. Peiker, A. L., **X-51 acrylic fiber: Scouring, dyeing, and finishing,** *Am. Dyestuff Reptr.* **41**, 162–3, 179 (1952); *Papers AATT* **7**, 116–18 (1952).

708. Point, J. J., **Structure and properties of polyacrylonitrile fibers,*** *Efficience textile* **6**, No. 11, 3, 5, 7–9, 11, 13–15, 17, 19–22 (1951) (*Chem. Abstracts* **46**, 5849c (1952)).

709. Point, J. J., **Structure and properties of polyacrylonitrile fibers: II: Mechanical properties,*** *Efficience textile* **6**, No. 12, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21–4 (1951) (*Chem. Abstracts* **46**, 8378h (1952)).

710. Soday, F. J., **The Chemstrand Corporation and Acrilan acrylic fiber,** *Papers AATT* **8**, 12–15 (1952).

711. Walker, E. E., **The solvent action of organic substances on polyacrylonitrile,** *J. Applied Chem.* **2**, 470–81 (1952).

(*c*) *Polyvinylalcohol*

712. Ferry, C., **A new artificial fiber with insulating properties,*** *Industrie textile* **67**, 246–50 (1950) (*Chem. Abstracts* **46**, 4236c (1952)).

713. Hidaka, S., and Suzuki, S., **Dyeing of vinylon: I: Swelling method with phenol in aqueous solution,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 435–6 (1951) (*Chem. Abstracts* **46**, 4235a (1952)).

714. Ikoma, I., and Kato, H., **Polyvinyl alcohol fibers: VI: Polyvinyl alcohol fibers cross-linked with dimethylenethiourea,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 377–9 (1950) (*Chem. Abstracts* **46**, 5321h (1952)).

715. Ikoma, I., and Kato, H., **Polyvinyl alcohol fibers: VII: Elastic properties of the cross-linked fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 440–1 (1950) (*Chem. Abstracts* **46**, 5321h (1952)).

716. Ikoma, I., and Kato, H., **Polyvinyl alcohol fibers: VIII: Hot water resistance and light fastness of the cross-linked fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 442–4 (1950) (*Chem. Abstracts* **46**, 5321i (1952)).

717. Ikoma, I., and Ohira, M., **Polyvinyl alcohol fibers: IV: Elasticity of cross-linked polyvinyl alcohol fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 19–21 (1950) (*Chem. Abstracts* **46**, 5321f (1952)).

718. Ikoma, I., and Ohira, M., **Polyvinyl alcohol fibers: V: Further elastic properties,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 85–7 (1950) (*Chem. Abstracts* **46**, 5321g (1952)).

719. Ikoma, I., Ohira, M., and Kato, H., **Polyvinyl alcohol fibers: II: Synthesis of formamide cross links in polyvinyl alcohol fiber,*** *J. Chem. Soc. Japan,* Ind. Chem. Sect., **53**, 138–9 (1950) (*Chem. Abstracts* **46**, 8411h (1952)).

720. Ikoma, I., Ohira, M., and Kato, H., **Polyvinyl alcohol fiber: III: Physical properties of the cross linked polyvinyl alcohol fiber,*** *J. Chem. Soc. Japan,* Ind. Chem. Sect., **53**, 167–8 (1950) (*Chem. Abstracts* **46**, 9852f (1952)).

721. Kuroyanagi, K., and Sakurada, I., **Thioglycolic acid ester of polyvinyl alcohol,*** *Chem. High Polymers* (Japan) **7**, 255–7 (1950) (*Chem. Abstracts* **46**, 10103h (1952)).

722. Kuwamura, S., Funakoshi, R., and Negishi, M., **Isocyanate treatment of polyvinyl alcohol: I: Diisocyanate treatment of polyvinyl alcohol fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 143–7 (1951) (*Chem. Abstracts* **46**, 6390f (1952)).

723. Makishima, K., and Naka, S., **Thermal properties of synthetic fibers: I: Softening characteristics of polyvinyl alcohol fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 198–202 (1950) (*Chem. Abstracts* **46**, 4802b (1952)).

724. Miyasaka, K., Fujii, S., and Watanabe, Y., **Fibrillar structure of fibers: I: Synthetic fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 387–8 (1951) (*Chem. Abstracts* **46**, 4802d (1952)).

725. Mori, N., **Vinylon filament yarn: I: Relationship between the spinning conditions and tensile properties,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 206–7 (1951) (*Chem. Abstracts* **46**, 6391f (1952)).

726. Mori, N., **Vinylon filament yarn: II: Continuous heat-treatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 208–10 (1951) (*Chem. Abstracts* **46**, 6391f (1952)).

727. Nagano, M., and Kobashi, I., **Mechanical properties of cellulose fibers as a function of the molecular distribution: II: Polyvinyl alcohol films,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 544–5 (1951) (*Chem. Abstracts* **46**, 5833f (1952)).

728. Nagano, M., and Yoshioka, Y., **Polyvinyl alcohol fibers: II: Degradation of the crystalline region of Vinylon,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 375–7 (1952) (*Chem. Abstracts* **47**, 325g (1953)).

729. Naka, S., and Makishima, K., **Thermal properties of synthetic fibers: II: Softening characteristics of untreated polyvinyl alcohol fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 264–7 (1950) (*Chem. Abstracts* **46**, 4802c (1952)).

730. Okajima, S., and Kobayashi, Y., **Dichroic study on polyvinylalcohol fiber: II: Effect of the crystallinity and moisture content of the fibers on their deformation,** *Bull. Chem. Soc. Japan* **25**, 267–71 (1952) (in English).

731. Ozawa, T., and Akuta, T., **Wet-heat treatment of polyvinyl alcohol fibers: VII: Change of the swelling-shrinkage force by heat-treatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 74–6 (1952) (*Chem. Abstracts* **46**, 9315f (1952)).

732. Ozawa, T., Akura, T., and Sukegawa, S., **Wet-heat treatment of polyvinyl alcohol fibers: VIII: Change of swelling properties in water by heat-treatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 76–9 (1952) (*Chem. Abstracts* **46**, 9315g (1952)).

733. Ozawa, T., Akuta, T., and Sukegawa, S., **Wet heat treatment of polyvinyl alcohol fibers: IX: Changes of the dye sorption by the heat treatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 378–80 (1952) (*Chem. Abstracts* **47**, 325b (1953)).

734. Ozawa, T., Akuta, T., and Sukegawa, S., **Wet heat treatment of polyvinyl alcohol fibers: X: Relation between stretching and the crystallinity,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 380–1 (1952) (*Chem. Abstracts* **47**, 325d (1953)).

735. Sakurada, I., **Synthetic fiber vinylon,*** *Bull. Inst. Chem. Research, Kyoto Univ. Commem. Vol. Silver Jubilee* **1951**, 84–91 (*Chem. Abstracts* **46**, 3285f (1952)).

736. Takahashi, J., **Poor dyeing of vinylon fibers: I,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 401–4 (1952) (*Chem. Abstracts* **47**, 325i (1953)).

737. Tokita, N., and Kawai, H., **Young's modulus and internal friction of polyvinylalcohol,** *J. Phys. Soc. Japan* **6**, 367–71 (1951) (in English).

738. Wheeler, O. L., Ernst, S. L., and Crozier, R. N., **Molecular weight degradation of polyvinyl acetate on hydrolysis,** *J. Polymer Sci.* **8**, 409–23 (1952).

739. Yoshida, T., and Adachi, T., **Improvement of vinylon dyeing by cresol treatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 350–2 (1952) (*Chem. Abstracts* **46**, 9313e (1952)).

See also [883]

2. *Mixed Polymers*

740. Chen, M. C., Ree, T., and Eyring, H., **Stress relaxation and shrinkage in fibers,** TEXTILE RESEARCH JOURNAL **22**, 416–23 (1952).

741. Okamura, S., Murata, T., and Yamashita, T., **Synthetic fibers from copolymers of vinyl acetate and acrylonitrile: II: Termination of copolymerization with low yields and the heterogeneity of the product in composition,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 501–4 (1950) (*Chem. Abstracts* **46**, 6390i (1952)).

742. Okamura, S., and Yamashita, T., **Synthetic fibers from copolymers of vinyl acetate and acrylonitrile: I: Fibers from copolymers composed mainly of vinyl acetate,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 202–5 (1950) (*Chem. Abstracts* **46**, 6390h (1952)).

743. Okamura, S., Yamashita, T., and Tsuchiya, M., **Synthetic fibers from copolymers of vinyl acetate and acryonitrile: III: Preparation of films and fibers from the copolymer of homogeneous composition,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 505–8 (1950) (*Chem. Abstracts* **46**, 6391a (1952)).

See also [703]

For papers on X-51 and Acrilan acrylic fibers, see [701–711]

D. *Miscellaneous*

744. Anon., **Ceramic melt blown into fibers,** *Chem. Eng.* **59**, No. 9, 222, 224, 226–7 (1952).

745. Bobeth, W., **The water sensitivity of glass fibers in the unworked and worked condition,*** *Faserforsch. u. Textiltech.* **3**, 142–6 (1952).

746. Frenzel, W., and Bobeth, W., **Binder twine from glass fiber,*** *Faserforsch. u. Textiltech.* **3**, 440–9 (1952).

747. Mongar, J. L., and Wassermann, A., **Adsorption of electrolyte by alginate gels without and with cation exchange,** *J. Chem. Soc.* **1952**, 492–7.

748. Mongar, J. L., and Wassermann, A., **Influence of ion exchange on optical properties, shape, and elasticity of fully-swollen alginate fibers,** *J. Chem. Soc.* **1952**, 500–10.

749. Roesti, H., **Dyeing and printing of glass fabrics,*** *Ciba Rundschau*, No. 98, 3617–18 (1951) (*J. Text. Inst.* **43**, A103 (1952)).

750. Ulrich, H. M., **Textile asbestos,*** *Melliand Textilber.* **33**, 188–90, 281–2 (1952).

V. HIGH-POLYMER STUDIES

A. *Mechanical Properties*

751. Andrews, R. D., **Correlation of dynamic and static measurements on rubberlike materials,** *Ind. Eng. Chem.* **44**, 707–15 (1952).

752. Bueche, F., **Viscosity, self-diffusion, and allied effects in solid polymers,** *J. Chem. Phys.* **20**, 1959–64 (1952).

753. Dekking, P., **Deformation mechanisms,** in **"Symposium on the Physics of Fibrous Materials"** (collected papers), Arnhem, Holland, 1950, pp. 47–55.

754. Ferry, J. D., Fitzgerald, E. R., Grandine, L. D., Jr., and Williams, M. L., **Temperature dependence of dynamic properties of elastomers: Relaxation distributions,** *Ind. Eng. Chem.* **44**, 703–6 (1952).

755. Ferry, J. D., and Williams, M. L., **Second approximation methods for determining the relaxation time spectrum of a viscoelastic material,** *J. Colloid Sci.* **7**, 347–53 (1952).

756. Gross, B., **The flow of solids,** *Phys. Today* **5**, No. 8, 6–11 (1952).

757. Isihara, A., Hashitsume, N., and Tatibana, M., **Statistical theory of rubber-like elasticity: V: The stress birefringence,** *J. Applied Phys.* **23**, 308–12 (1952).

758. Kubát, J., **Rheological relaxation processes,*** *Kolloid-Z.* **129**, 73–7 (1952).

759. Lyons, W. J., **Distribution of activation energies for viscoelastic deformation,** *J. Applied Phys.* **23**, 287–8 (1952) (Letter to the Editor).

HIGH-POLYMER STUDIES

760. Mooney, M., and Wolstenholme, W. E., **Modulus and relaxation of elastomers in torsion at low temperatures,** *Ind. Eng. Chem.* **44**, 335–42 (1952).

761. Murnaghan, F. D., **"Finite deformation of an elastic solid,"** New York, John Wiley and Sons, and London, Chapman and Hall, 1951, 140 pp.

762. Päsler, M., **Thermal damping in vibrating solid,*** *Kolloid-Z.* **129**, 65–72 (1952).

763. Schmieder, K., and Wolf, K., **The temperature- and frequency-dependence of the mechanical behavior of some high polymer substances,*** *Kolloid-Z.* **127**, 65–78 (1952).

764. Schwarzl, F., and Staverman, A. J., **Time-temperature dependence of linear viscoelastic behavior,** *J. Applied Phys.* **23**, 838–43 (1952).

765. Scott Blair, G. W., **The application of Nutting's equation to the viscoelastic behavior of certain polymeric systems (with authors' comment by R. Buchdahl and L. E. Nielsen),** *J. Applied Phys.* **23**, 600 (1952) (Letter to the Editor).

766. Stuart, H. A., **Influence of molecular order on the technological properties of high polymers,*** *Kunststoffe* **42**, 266–72 (1952).

See also [661, 668]

B. Relation of Structure to Mechanical Properties

767. Barg, E. I., Spitkovskii, D. M., and Mel'teva, N. N., **Elastic elongation of polymers,*** *Doklady Akad. Nauk S.S.S.R.* **84**, 257–60 (1952) (*J. Text. Inst.* **43**, A924 (1952)).

768. Boyer, R. F., **Ratio of tensile strength to melt viscosity for high polymeric materials,** *J. Polymer Sci.* **9**, 289–94 (1952).

769. Cheatham, R. G., and Dietz, A. G. H., **Effect of orientation on the mechanical properties of polystyrene,** *Trans. Am. Soc. Mech. Engrs.* **74**, 31–40 (1952).

770. Dole, M., Hettinger, W. P., Jr., Larson, N. R., and Wethington, J. A., Jr., **Specific heat of synthetic high polymers: I: A study of polyethylene including a statistical theory of crystallite length,** *J. Chem. Phys.* **20**, 781–90 (1952).

771. Gehman, S. D., **Relationship between molecular structure and physical properties,** *Ind. Eng. Chem.* **44**, 730–9 (1952).

772. George, W., **Nucleation and growth of flow and fracture markings,** *Ind. Eng. Chem.* **44**, 1328–31 (1952).

773. Hsiao, C. C., **Effect of orientation on the ultimate strength of linear high polymers,** *J. Applied Phys.* **23**, 1189–90 (1952) (Letter to the Editor).

774. Izard, E. F., **The effect of chemical composition on selected physical properties of linear polymers,** *J. Polymer Sci.* **8**, 503–18 (1952).

775. Jellinek, H. H. G., **Degradation of long chain molecules as a reverse polymerization process,** *J. Polymer Sci.* **9**, 369–80 (1952).

776. Korshak, V. V., **High molecular weight compounds: 40: Relative tendencies of macromolecules of various lengths to undergo degradation,*** *Izvest. Akad. Nauk S.S.S.R., Otdel. Krim. Nauk* **1951**, 753–5 (*J. Soc. Dyers and Colourists* **68**, 332 (1952)).

777. Krimm, S., **Orientation of crystallites in stretched polyethylene,** *J. Applied Phys.* **23**, 287 (1952) (Letter to the Editor).

778. Rugg, F. M., Smith, J. J., and Atkinson, J. V., **Effect of cold drawing on the infrared band of polyethylene at 13.7 microns,** *J. Polymer Sci.* **9**, 579–81 (1952) (Letter to the Editor).

779. Simha, R., **On the statistical theory of crystallite length,** *J. Chem. Phys.* **20**, 1654 (1952) (Letter to the Editor).

780. Trillat, J.-J., Barbezat, S., and Delalande, A., **Variation in the crystallinity of polyethylenes as a function of temperature,*** *J. chim. phys.* **47**, 877–82 (1950).

781. Wang, M. C., and Guth, E., **Statistical theory of networks of non-Gaussian flexible chains,** *J. Chem. Phys.* **20**, 1144–57 (1952).

782. Williams, J. L., Cleereman, K. J., Karam, H. J., and Rinn, H. W., **Orientation study of polystyrene monofilaments by means of x-ray and birefringence,** *J. Polymer Sci.* **8**, 345–6 (1952) (Letter to the Editor).

See also [613]

C. Properties of High-Polymer Solutions

783. Baker, W. O., Mason, W. P., and Heiss, J. H., **Mechanical properties of discrete polymer molecules,** *J. Polymer Sci.* **8**, 129–55 (1952).

784. Cerf, R., **The action of transverse ultrasonic waves on solutions of rigid high polymers,*** *Compt. rend.* **234**, 1549–51 (1952).

785. Cerf, R., **Effect of transverse ultrasonic waves on solutions of high polymers,*** *Compt. rend.* **233**, 1099–1101 (1951).

786. DeButts, E. H., **Distribution of ions in solutions of weak electrolytes,** *J. Phys. Chem.* **56**, 60–3 (1952).

787. Debye, P., and Bueche, F., **Distribution of segments in a coiling polymer molecule,** *J. Chem. Phys.* **20**, 1337–8 (1952) (Letter to the Editor).

788. Grimley, T. B., **High-polymer solutions,** *Proc. Roy. Soc.* (London) **A212**, 339–61 (1952).

789. Hermans, J. J., Klamkin, M. S., and Ullman, R., **The excluded volume of polymer chains,** *J. Chem. Phys.* **20**, 1360–8 (1952).

790. Hill, T. L., **Size and shape of polyelectrolye molecules in solution,** *J. Chem. Phys.* **20**, 1173–4 (1952) (Letter to the Editor).

791. Hollingsworth, C. A., **Solutions of some problems concerning long random coils,** *J. Chem. Phys.* **20**, 1580–90 (1952).

792. Kimball, G. E., Cutler, M., and Samelson, H., **A theory of polyelectrolytes,** *J. Phys. Chem.* **56**, 57–60 (1952).

793. Kirkwood, J. G., and Mazur, J., **The radial distribution functions of electrically charged macromolecules in solution,** *J. Polymer Sci.* **9**, 519–24 (1952).

794. Munster, A., **On a generalization of statistical theories for high polymer solutions,*** *J. chim. phys.* **49**, 128–39 (1952).

795. Peterlin, A., **The viscous behavior of high polymers and polyelectrolytes,*** *Kunststoffe* **42**, 437–44 (1952).

796. Rubin, R. J., **The excluded volume effect in polymer chains and the analogous random walk problem,** *J. Chem. Phys.* **20**, 1940–5 (1952).

797. Scheibling, G., **Transport diffusion in mixtures: Application to the study of polydispersity of solutions,*** *J. chim. phys.* **47**, 688–92 (1950).

798. Scott, R. L., **Thermodynamics of high polymer solutions: VI: The compatibility of copolymers,** *J. Polymer Sci.* **9**, 423–32 (1952).

799. Stauff, J., **Thermodynamically stable association-colloids,*** *Kolloid-Z.* **125**, 79–86 (1952).
800. Teramoto, E., **The excluded-volume effect in a polymer chain: I,*** *Busseiron Kenkyû* (Researches on Chem. Phys.) **42**, 24–35 (1951) (*Chem. Abstracts* **46**, 1844h (1952)).
801. Thiele, H., and Lamp, H., **The spinnability of colloidal solutions,*** *Kolloid-Z.* **129**, 25–39 (1952).
802. TSvetkov, V. N., Krozer, S. P., and Terent'eva, L. S., **The effect of concentration on the rate of diffusion of some polymers in a solution,*** *Doklady Akad. Nauk S.S.S.R.* **85**, 313–16 (1952) (*J. Text. Inst.* **43**, A951 (1952)).
803. Yamamoto, M., **The excluded-volume effect in a polymer chain: II,*** *Busseiron Kenkyû* (Researches on Chem. Phys.) **44**, 36–43 (1951) (*Chem. Abstracts* **46**, 1844i (1952)).

D. Absorption, Swelling, and Diffusion

804. Balázs, N. L., **Some notes on the statistical theory of adsorption,** *Physica* **17**, 865–75 (1951) (in English).
805. Bueche, F., Cashin, W. M., and Debye, P., **The measurement of self-diffusion in solid polymers,** *J. Chem. Phys.* **20**, 1956–8 (1952).
806. Calvet, E., **Thermo-kinetic study of adsorption: The case of soluble bodies and macromolecular substances,*** *J. Polymer Sci.* **8**, 163–71 (1952).
807. Crank, J., **Simultaneous diffusion and reversible chemical reaction,** *Phil. Mag.* **43**, 811–26 (1952).
808. Everett, D. H., and Whitton, W. I., **A general approach to hysteresis,** *Trans. Faraday Soc.* **48**, 749–57 + 1 plate (1952).
809. Everett, D. H., and Young, D. M., **The thermodynamics of adsorption: 4: The onset of multilayer formation,** *Trans. Faraday Soc.* **48**, 1164–70 (1952).
810. Foster, A. G., **Sorption hysteresis: II: The role of the cylindrical meniscus effect,** *J. Chem. Soc.* **1952**, 1806–12.
811. Fujita, H., **Corrèction to "A numerical solution of the differential equation for adsorption-controlled diffusion in a solid,"** TEXTILE RESEARCH JOURNAL **22**, 556 (1952) (Letter to the Editor).
812. Fujita, H., **The exact pattern of a concentration-dependent diffusion in a semi-infinite medium,** TEXTILE RESEARCH JOURNAL **22**, 757–60, 823–7 (1952).
813. Fujita, H., **A numerical solution of the differential equation for adsorption-controlled diffusion in a solid,** TEXTILE RESEARCH JOURNAL **22**, 281–6 (1952).
814. Fujita, H., and Kishimoto, A., **A method of determining the concentration dependence of the diffusion coefficient,** TEXTILE RESEARCH JOURNAL **22**, 94–5 (1952) (Letter to the Editor).
815. Higuti, I., and Iwagami, Y., **Calorimetric evidence for the capillary condensation theory,** *J. Phys. Chem.* **56**, 921–7 (1952).
816. Hill, T. L., **Statistical thermodynamics of the transition region between two phases: I: Thermodynamics and quasi-thermodynamics,** *J. Phys. Chem.* **56**, 526–31 (1952).
817. Hill, T. L., and Rowen, J. W., **Sorption of vapors by polymers,** *J. Polymer Sci.* **9**, 93–5 (1952) (Letter to the Editor).
818. Hwang, J. L., **On the calculation of diffusion coefficients from sorption data,** *J. Chem. Phys.* **20**, 1320–3 (1952).
819. Innes, W. B., **The treatment of complex adsorbates as a single phase (with comments by T. L. Hill),** *J. Colloid Sci.* **7**, 447–50 (1952) (Letter to the Editor).
820. Jones, W. M., **Mobility in a sorbed layer: II: Surface flow through pores of molecular dimensions,** *Trans. Faraday Soc.* **48**, 562–7 (1952).
821. Kokes, R. J., Long, F. A., and Hoard, J. L., **Diffusion of acetone into polyvinyl acetate above and below the second-order transition,** *J. Chem. Phys.* **20**, 1711–16 (1952).
822. Mackor, E. L., and van der Waals, J. H., **The statistics of the adsorption of rod-shaped molecules in connection with the stability of certain colloidal dispersions,** *J. Colloid Sci.* **7**, 535–50 (1952).
823. Park, G. S., **The determination of the concentration dependent diffusion coefficient for methylene chloride in polystyrene by a steady state method,** *Trans. Faraday Soc.* **48**, 11–21 (1952).
824. Staverman, A. J., **Non-equilibrium thermodynamics of membrane processes,** *Trans. Faraday Soc.* **48**, 176–85 (1952).
825. Stokes, R. H., **One-dimensional diffusion with the diffusion coefficient a linear function of concentration,** *Trans. Faraday Soc.* **48**, 887–92 (1952).
826. Theimer, O., **On multilayer adsorption isotherms,** *Trans. Faraday Soc.* **48**, 326–31 (1952).
827. Troesch, A., **Contribution to a generalization of the multimolecular adsorption equations of Brunauer, Emmett, and Teller and of Hüttig,*** *J. chim. phys.* **48**, 454–64 (1951).

See also [752]

VI. MOLECULAR-WEIGHT DETERMINATION

A. Viscosity

1. General and Theoretical Papers

828. Akkerman, F., Pals, D. T. F., and Hermans, J. J., **Non-Newtonian flow of dilute polymer solutions: III: Sodium carboxymethylcellulose in solutions of sodium chloride,** *Rec. trav. chim.* **71**, 56–63 (1952) (in English).
829. Bondi, A., **Viscosity and molecular structure,** *Ann. N. Y. Acad. Sci.* **53**, 870–905 (1951).
830. Bywater, S., **Viscometric determinations of various molecular weight averages of polymers,** *Chemistry & Industry* **1952**, 67.
831. Cerf, R., **On the frequency dependence of the viscosity of high polymer solutions,** *J. Chem. Phys.* **20**, 395–402 (1952).
832. Cleverdon, D., and Smith, P. G., **Polymer weight-average molecular weight by viscometry,** *Chemistry & Industry* **1951**, 937.
833. Cleverdon, D., and Smith, P. G., **The significance of the true intrinsic viscosity,** *Chemistry & Industry* **1952**, 67.
834. Conrad, C. M., and Ziifle, H. M., **Implications of Philippoff flow curves for the determination of intrinsic viscosity of high polymer nitrocelluloses,** *J. Colloid Sci.* **7**, 227–35 (1952).
835. Cragg, L. H., **The relation between the Huggins slope constant *k'* and intrinsic viscosity, and the so-called "true" intrinsic viscosity (with remarks by D. Cleverdon and P. G. Smith),** *Chemistry & Industry* **1952**, 623–4.

MOLECULAR-WEIGHT DETERMINATION

836. Cragg, L. H., and Sones, R. H., **Viscosity slope constant *k'* and its variation with molecular weight and temperature,** *J. Polymer Sci.* **9**, 585–8 (1952) (Letter to the Editor).

837. Doolittle, A. K., **Studies in Newtonian flow: III: The dependence of the viscosity of liquids on molecular weight and free space (in homologous series),** *J. Applied Phys.* **23**, 236–9 (1952).

838. Doolittle, A. K., **Studies in Newtonian flow: IV: Viscosity *vs.* molecular weight in liquids; viscosity *vs.* concentration in polymer solutions,** *J. Applied Phys.* **23**, 418–26 (1952).

839. Edelmann, K., **The rheology of solutions of high polymers: I: General principles,*** *Faserforsch. u. Textiltech.* **3**, 341–4 (1952).

840. Edelmann, K., **The rheology of solutions of high polymers: II: Structural viscosity measurements on cellulose nitrates in butyl acetate,*** *Faserforsch. u. Textiltech.* **3**, 344–9 (1952).

841. Fraenkel, G. K., **Visco-elastic effect in solutions of simple particles,** *J. Chem. Phys.* **20**, 642–7 (1952).

842. Fromm, H., and Hartung, W., **Measurement of the shear modulus of viscous liquids,*** *Die Technik* **7**, 126–30 (1952) (*Science Abstracts* **A55**, 595 (1952)).

843. Harland, W. G., **Relation between intrinsic viscosity and degree of polymerization,** *Nature* **170**, 667 (1952) (Letter to the Editor).

844. Karim, S. M., and Rosenhead, L., **The second coefficient of viscosity of liquids and gases,** *Revs. Mod. Phys.* **24**, 108–16 (1952).

845. Katchalsky, A., and Sternberg, N., **The extension of Poiseuille's equation to non-Newtonian liquids,** *Bull. Research Council Israel* **1**, No. 3, 111–13 (1951) (*Chem. Abstracts* **46**, 6461i (1952)).

846. Krigbaum, W. R., Mandelkern, L., and Flory, P. J., **Molecular weight dependence of intrinsic viscosity of polymer solutions,** *J. Polymer Sci.* **9**, 381–4 (1952).

847. Kuhn, H., and Kuhn, W., **Effects of hampered draining of solvent on the translatory and rotatory motion of statistically coiled long-chain molecules in solution: II: Rotatory motion, viscosity, and flow birefringence,** *J. Polymer Sci.* **9**, 1–33 (1952).

848. Litovitz, T. A., **Temperature dependence of the viscosity of associated liquids,** *J. Chem. Phys.* **20**, 1088–9 (1952).

849. Mizutani, H., **The causes of the structural viscosity of high-polymer solutions,*** *Busseiron Kenkyû* (Researches on Chem. Phys.), No. 41, 42–60 (1951); No. 50, 1–13 (1952) (*Chem. Abstracts* **46**, 1844a, 7846e (1952)).

850. Moore, W. R., and Russell, J., **Critical concentration effects in the viscosities of dilute solutions of high polymers,** *J. Polymer Sci.* **9**, 472–5 (1952) (Letter to the Editor).

851. Oguri, S., Sekine, Y., and Kashiwagi, M., **Structural viscosity: II: Abnormal viscosity of cellulose derivatives,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 516–18 (1950) (*Chem. Abstracts* **46**, 6826d (1952)).

852. Pepper, D. C., **The intrinsic viscosity of low molecular weight polystyrenes,** *Sci. Proc. Roy. Dublin Soc.* **25**, 239–50 (1951).

853. Peterlin, A., **Effect of the velocity gradient on intrinsic viscosity of polymers in solution,** *J. Polymer Sci.* **8**, 621–32 (1952).

854. Peterlin, A., **Statistics of linear macromolecules with a relatively short chain: IV: Molecular dimensions from viscosity and sedimentation,** *J. Polymer Sci.* **8**, 173–85 (1952).

855. Saitô, N., **A remark on the hydrodynamical theory of the viscosity of solutions of macromolecules,** *J. Phys. Soc. Japan* **7**, 447–50 (1952) (in English).

856. Schulz, G. V., **Molecular weight determination on macromolecular substances: A critical evaluation and comparison of different methods,*** *Experientia* **8**, 171–82 (1952) (in German).

857. Suzuki, K., **Shape of linear polyelectrolyte molecules,*** *Busseiron Kenkyû* (Researches on Chem. Phys.), No. 25, 77–86 (1950) (*Chem. Abstracts* **46**, 9947d (1952)).

858. Takei, M., **Studies on the soluble states of high-molecular compounds: VIII: Structural viscosity of the solution of cellulose acetate in various solvents,*** *J. Chem. Soc. Japan,* Pure Chem. Sect., **69**, 26–7 (1948) (*Chem. Abstracts* **46**, 9301c (1952)).

859. Tripp, V. W., Conrad, C. M., and Mares, T., **Some relations between intrinsic and specific viscosity in cellulose solutions at a controlled velocity gradient,** *J. Phys. Chem.* **56**, 693–6 (1952).

860. Weltmann, R. N., and Kuhns, P. W., **Effect of shear temperature on viscosity in a rotational viscometer measurement,** *J. Colloid Sci.* **7**, 218–26 (1952).

861. de Wind, G., and Hermans, J. J., **Non-Newtonian flow of dilute polymer solutions: II: Solutions of cellulose nitrate in acetone,** *Rec. trav. chim.* **70**, 615–37 (1951) (in English).

See also [897, 919]

2. *Methods and Instruments*

862. Arisawa, Y., and Hatano, A., **Cupriethylenediamine as a solvent for the precise determination of pulp viscosity,*** *J. Japan. Tech. Assoc. Pulp Paper Ind.* **6**, 263–71, 322 (1952) (*Chem. Abstracts* **46**, 11679e (1952)).

863. Cox, L. A., and Battista, O. A., **Basic degree of polymerization of cellulose acetate,** *Ind. Eng. Chem.* **44**, 893–6 (1952).

864. Doering, H., **Rapid method for determining the degree of polymerization of cellulose according to Staudinger,*** *Das Papier* **5**, 507–10 (1951) (*Chem. Abstracts* **46**, 4221i (1952)).

865. Edelmann, K., **A rapid method for determining the D.P. of cellulose by the nitrate procedure,*** *Faserforsch. u. Textiltech.* **3**, 301–2 (1952).

866. Ellefson, Ø., **Sources of error in capillary viscometer measurements,*** *Papirindustr. Forsk. Instit.,* Meddel Nr. 35, 1–10 (1951) (*J. Text. Inst.* **43**, A131 (1952)).

867. Fromm, H., **The relaxation correction in capillary viscometery: An investigation into the question of standardization of ideas and calculations,*** *Kolloid-Z.* **126**, 72–7 (1952).

868. Gran, G., and Wetlesen, C.-U., **Determination of ethylenediamine in cupriethylenediamine solutions,** *Acta Chem. Scand.* **6**, 807–8 (1952) (in English).

869. Higginbotham, R. S., and Benbow, J. J., **Two viscometers for rapid measurements at definite shearing stresses,** *J. Sci. Instruments* **29**, 221–4 (1952).

870. Hull, H. H., **The band viscometer,** *J. Colloid Sci.* **7**, 316–22 (1952).

871. Ibrahim, A. A. K., and Kabiel, A. M., **On the oscillating cylinder viscometer: I,** *J. Applied Phys.* **23**, 1190 (1952) (Letter to the Editor).

872. Krieger, I. M., and Maron, S. H., **Direct determination of the flow curves of non-Newtonian fluids,** *J. Applied Phys.* **23**, 147–9, 1412 (1952).
873. Oldroyd, J. G., **The motion of an elastico-viscous liquid contained between coaxial cylinders: I,** *Quart. J. Mech. Appl. Math.* **4**, 271–82 (1951) (*J. Text. Inst.* **43**, A774 (1952)).
874. Rutishauser, M., and Weber, A., **A rapid method for determining the viscosity of cuprammonium (with remarks by H. Doering and M. Rutishauser),*** *Svensk Papperstidn.* **55**, 67–71, 406–7 (1952).
875. Schurz, J., and Immergut, E. H., **Instrument for determining shear dependence of intrinsic viscosity of high polymer solutions,** *J. Polymer Sci.* **9**, 279–81 (1952) (Letter to the Editor).
876. Signer, R., and Berneis, K., **A capillary viscometer for low velocity gradients,*** *Makromol. Chem.* **8**, 268–82 (1952).
877. Valtasaari, L., **Intrinsic viscosity of cellulose in cupriethylenediamine solution,** *Paper and Timber* (Finland) **34**, 58–62 (1952) (in English) (*Bull. Inst. Paper Chem.* **22**, 658 (1952)).
878. Vollenbruck, H., **DP-determination on cellulose fibers,*** *Melliand Textilber.* **33**, 153–6 (1952).
879. Wilson, K., **A tentative method for determination of viscosity of cellulose dissolved in cupriethylenediamine,** *Svensk Papperstidn.* **55**, 125–32 (1952) (in English).

B. Osmotic Pressure

880. Benoit, A.-M., **Determination of radius of the equivalent particle by osmotic pressure measurements,*** *J. chim. phys.* **47**, 655–8 (1950).
881. Breitenbach, J. W., and Forster, E. L., **Permeability of Ultracella filter-membranes to low molecular-weight liquids,*** *Makromol. Chem.* **8**, 140–6 (1952).
882. Cleverdon, D., **Practice of osmometry: Its contribution to the characterization of a high polymer,** *J. Applied Chem.* **1**, 272–80 (1951).
883. Fuchs, O., **Remarks on the determination of the degree of polymerization of polyvinyl alcohol by osmometry,*** *Makromol. Chem.* **7**, 271–3 (1952).
884. Guggenheim, E. A., and McGlashan, M. L., **The determination of molecular weights of macromolecules from measurements of osmotic pressure,** *Trans. Faraday Soc.* **48**, 206–11 (1952).
885. Hanks, G. A., and Weissberg, S. G., **A convenient small osmometer,** *J. Research Natl. Bur. Standards* **49**, 393–6 (1952).
886. Hookway, H. T., and Townsend, R., **High-polymer solutions: I: Osmotic pressure measurements with poly(vinyl alcohol) membranes,** *J. Chem. Soc.* **1952**, 3190–5.
887. Krigbaum, W. R., and Flory, P. J., **Treatment of osmotic pressure data,** *J. Polymer Sci.* **9**, 503–8 (1952).
888. Lang, H., **The evaluation of osmotic measurements: Processes at perpendicularly placed membranes,*** *Kolloid-Z.* **128**, 7–15 (1952).
889. Lang, H., and Münster, A., **The effect of chain mobility on the osmotic pressure of high-molecular solutions,*** *Naturwissenschaften* **38**, 68 (1951).
890. Moelwyn-Hughes, E. A., **Osmotic pressure,*** *Z. Elektrochem.* **55**, 518–25 (1951).
891. Münster, A., **Investigations on the system nitrocellulose-acetone,** *J. Polymer Sci.* **8**, 633–49 (1952).
892. Pinner, S. H., and Stabin, J. V., **A high temperature osmometer,** *J. Polymer Sci.* **9**, 575–9 (1952) (Letter to the Editor).
893. Staverman, A. J., **Apparent osmotic pressure of solutions of heterodisperse polymers,** *Rec. trav. chim.* **71**, 623–33 (1951) (in English).
894. Stockmayer, W. H., and Casassa, E. F., **The third virial coefficient in polymer solutions,** *J. Chem. Phys.* **20**, 1560–6 (1952).

See also [856]

C. Sedimentation and Diffusion

895. Dobrowsky, A., **The algebraic calculation of axially symmetric diffusion and its representation using a hydrodynamic model (method of stream segments),*** *Kolloid-Z.* **126**, 1–14 (1952).
896. Gosting, L. J., **Solution of boundary spreading equations for electrophoresis and the velocity ultracentrifuge,** *J. Am. Chem. Soc.* **74**, 1548–52 (1952).
897. Ivanov, V. I., and Sacharov, B. A., **The relation of the molecular weight of cellulose to viscosity, sedimentation and diffusion measurements,*** *Faserforsch. u. Textiltech.* **3**, 237–8 (1952).
898. Krigbaum, W. R., and Flory, P. J., **Statistical mechanics of dilute polymer solutions: III: Ternary mixtures of two polymers and a solvent,** *J. Chem. Phys.* **20**, 873–6 (1952).
899. Mandelkern, L., and Flory, P. J., **The frictional coefficient for flexible chain molecules in dilute solution,** *J. Chem. Phys.* **20**, 212–14 (1952).
900. Mandelkern, L., Krigbaum, W. R., Scheraga, H. A., and Flory, P. J., **Sedimentation behavior of flexible chain molecules: Polyisobutylene,** *J. Chem. Phys.* **20**, 1392–7 (1952).
901. Peterlin, A., **Statistical model of large linear molecules with short chains: II: Sedimentation and diffusion,*** *J. chim. phys.* **48**, 13–16 (1951).
902. Schachman, H. K., and Harrington, W. F., **On viscosity measurement in the ultra-centrifuge,** *J. Am. Chem. Soc.* **74**, 3965–6 (1952) (Letter to the Editor).
903. Tschmutov, K. V., and Sslonim, S. J., **Methods for determining the rate of diffusion of high-molecular substances,*** *Uspekhi Khim.* **19**, 142–56 (1950) (*Faserforsch. u. Textiltech.* **3**, 75–7 (1952)).
904. Wales, M., and Williams, J. W., **Effect of solvation on sedimentation experiments,** *J. Polymer Sci.* **8**, 449–56 (1952).
905. Waugh, D. F., and Yphantis, D. A., **Rotor temperature measurement and control in the ultracentrifuge,** *Rev. Sci. Instruments* **23**, 609–14 (1952).
906. Zakharov, B. A., **Calculation of the molecular weights of cellulosic materials from the constants of sedimentation or diffusion,*** *Doklady Akad. Nauk S.S.S.R.* **81**, 629–31 (1951) (*Chem. Abstracts* **46**, 4220h (1952)).

See also [854, 856]

D. Light Scattering

907. Bosworth, P., Masson, C. R., Melville, H. W., and Peaker, F. W., **Determination of the molecular weights of fractionated polyvinyl acetates by a new type of light-scattering instrument,** *J. Polymer Sci.* **9**, 565–74 (1952).
908. Bueche, F., **Light scattering by pure polystyrene,** *J. Applied Phys.* **23**, 1280–1 (1952) (Letter to the Editor).

MOLECULAR-WEIGHT DETERMINATION

909. Horn, P., **Experimental contribution to the study of light scattering by solutions containing very elongated particles,*** *Compt. rend.* **234**, 1870–3 (1952).

910. Mommaerts, W. F. H. M., **The measurement of light-scattering intensities according to Brice,** *J. Colloid Sci.* **7**, 71–9 (1952).

911. Oster, G., **Determination of absolute turbidities,** *J. Polymer Sci.* **9**, 525–6 (1952).

912. Prasad, M., Subramanian, K. E., Desai, R. L., and Kanekar, C. R., **Light scattering by some thixotropic gels,** *J. Colloid Sci.* **7**, 178–85 (1952).

913. Saitô, N., and Ikeda, Y., **The light scattering by non-spherical particles in solutions,** *J. Phys. Soc. Japan* **6**, 305–8 (1951) (in English).

914. Sheffer, H., and Hyde, J. C., **An important reflectance correction in light-scattering studies,** *Can. J. Chem.* **30**, 817–20 (1952).

915. Thurmond, C. D., **Control of dust in solutions for turbidimetry,** *J. Polymer Sci.* **8**, 607–9 (1952).

See also [856, 898]

E. Flow Birefringence

916. Cerf, R., and Scheraga, H. A., **Flow birefringence in solutions of macromolecules,** *Chem. Revs.* **51**, 185–261 (1952).

917. Edsall, J. T., Rich, A., and Goldstein, M., **An instrument for the study of double refraction of flow at low and intermediate velocity gradients,** *Rev. Sci. Instruments* **23**, 695–701 (1952).

918. Goldstein, M., **Flow birefringence in polydisperse systems of rod-like molecules having a Montroll-Simha distribution,** *J. Chem. Phys.* **20**, 677–82 (1952).

919. Isihara, A., **Behavior of linear polymers in solution,** *J. Polymer Sci.* **8**, 574–6 (1952) (Letter to the Editor).

920. Joly, M., **Orientation by flow of rigid particles which repel each other: Application to dynamic birefringence,*** *J. phys. radium* **12**, 900–11 (1951).

921. Joly, M., **Theory of the orientation of rigid particles by interaction during streaming,*** *Kolloid-Z.* **126**, 77–87 (1952).

922. Joly, M., **The use of streaming birefringence data to determine the size and size distribution of rod-shaped interacting particles,** *Trans. Faraday Soc.* **48**, 279–86 (1952).

923. Zucker, D., Foster, J. F., and Miller, G. H., **Design and performance of a photoelectric circuit for measurement of streaming birefringence and dichroism,** *J. Phys. Chem.* **56**, 166–70 (1952).

F. Fractionation

924. Boyer, R. F., **Molecular weight distributions in polystyrene: II: Experimental,** *J. Polymer Sci.* **9**, 197–218 (1952).

925. Boyer, R. F., **A new molecular weight distribution technique for polystyrene: I: Theory,** *J. Polymer Sci.* **8**, 73–90 (1952); **Erratum,** *ibid.* **9**, 216 (1952).

926. Desreux, V., and Oth, A., **Theory and practice of fractionation,*** *Chem. Weekblad* **48**, 247–59 (1952).

927. Fuchs, O., **Fractionation of high polymers by the method of partial solution,*** *Makromol. Chem.* **7**, 259–70 (1952).

928. Kirkwood, J. G., and Brown, R. A., **Diffusion-convection: A new method for the fractionation of macromolecules,** *J. Am. Chem. Soc.* **74**, 1056–8 (1952).

929. Nakahara, H., and Shihanda, M., **Determination of polymolecularity in cellulose materials: I: Molecular weight distribution,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 438–41 (1952) (*Chem. Abstracts* **47**, 308b (1953)).

930. Rosenthal, A. J., and White, B. B., **Fractionation of cellulose acetate,** *Ind. Eng. Chem.* **44**, 2693–6 (1952).

931. Shulyatikova, N. V., and Mandel'baum, D. I., **Fractionation of cellulose with cuprammonium solutions,*** *Zhur. Priklad. Khim.* **24**, 264–73 (1951) (*Chem. Abstracts* **46**, 252g (1952)).

932. Sobue, H., Matsuzaki, K., and Iwata, T., **Fractionation of cellulose and its derivatives: IV: Chain-length distribution of rayons,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 599–602 (1951) (*Chem. Abstracts* **46**, 6378g (1952)).

933. Stockmayer, W. H., **Molecular distribution in condensation polymers,** *J. Polymer Sci.* **9**, 69–71 (1952).

See also [23, 50, 143, 232, 233, 623]

VII. DETERIORATION OF MATERIALS

A. Microbiological Degradation

934. Basu, S. N., and Ghose, S. N., **Fungal decomposition of jute fibre and cellulose: IV: The action of some physical and chemical agencies on subsequent fungal decomposition of jute,** *J. Text. Inst.* **43**, T355–61 (1952).

935. Bayley, C. H., **The effect of micro-organisms and of weathering on cotton textiles,** *Can. Text. J.* **69**, No. 9, 59–63 (1952).

936. Blum, R., and Stahl, W. H., **Enzymic degradation of cellulose fibers,** TEXTILE RESEARCH JOURNAL **22**, 178–92 (1952).

937. Burnthall, E. V., **The microbiological degradation of wool,** *Can. Text. J.* **69**, No. 10, 62–4, 67 (1952).

938. Castle, V., **The development of a test for the quantitative assessment of microbiological degradation of cotton,** *Selected Govt. Research Repts.* (London) (Textiles and Their Testing) **4**, 71–6 (1949) (*Chem. Abstracts* **46**, 5851a (1952)).

939. Chatterjee, H., and Pal, K. B., **Rotproofing jute textiles,** *Textile Manufacturer* **78**, 228–31 (1952).

940. Coke, C. E., **The effects of micro-organisms and weathering on man-made fibres,** *Can. Text. J.* **69**, No. 9, 53–4, 57–8 (1952).

941. Dachtler, H., **Micro-organisms of the human skin and their effect on various textile fibers,*** *Melliand Textilber.* **33**, 705–10, 997–1000 (1952).

942. De Stevens, G., and Nord, F. F., **Investigations on lignin and lignification: IX: The relationship between the action of brown rot fungi, cellulose degradation and lignin composition in bagasse,** *J. Am. Chem. Soc.* **74**, 3326–8 (1952).

943. Fear, E. J. P., and Fennell, T. R. F. W., **Control tests for process specifications for rot-proofing of textiles,** *Selected Govt. Research Repts.* (London) (Textiles and Their Testing) **4**, 77–84 (1949) (*Chem. Abstracts* **46**, 5852c (1952)).

944. Meeuse, A. D. J., **The Vezelinstituut method for testing fabrics and yarns for resistance to rotting and molds,*** *De Tex* **10**, 1020, 1023–4, 1026 (1951) (*Chem. Abstracts* **46**, 7335f (1952)).

945. Nishizawa, K., Matsuzaki, H., and Higuchi, A., **Cellulase: I: Action of cellulase from Irpex lacteus on various cellulose samples,*** *Symposia on Enzyme Chem.* (Japan) **4**, 75 (1950) (*Chem. Abstracts* **46**, 2096i (1952)).

946. Nopitsch, M., **Bacteria as the cause of textile damage,*** *Z. ges. Textil-Ind.* **54**, 610, 613–16, 619 (1952).

947. Ostertag, H., **Cellulose-decomposing microörganisms,*** *Z. Hyg. Infektionskrankh.* **133**, 489–509 (1952) (*Chem. Abstracts* **46**, 6183e (1952)).

948. Perrin, E. E., **Copper 3-phenylsalicylate—a textile preservative,** *Rayon and Synthetic Texts.* **33**, No. 4, 78, 80 (1952).

949. Ray, D. L., and Julian, J. R., **Occurrence of cellulase in *Limnoria,*** *Nature* **169**, 32–3 (1952) (Letter to the Editor).

950. Von Goehde, H. L., **Copper as a textile fiber preservative,** *Am. Dyestuff Reptr.* **41**, 164, 179 (1952).

951. Walseth, C. S., **Occurrence of cellulases in enzyme preparations from microorganisms,** *Tappi* **35**, 228–33 (1952) (*Bull. Inst. Paper Chem.* **22**, 739 (1952)).

952. Zusman, M. N., IAkubenko, Z. K., and Petrova, E. A., **Role of dichromate in the [rotproofing] treatment of fabrics,*** *Tekstil. Prom.* **11**, No. 8, 27 (1951) (*J. Soc. Dyers and Colourists* **68**, 42 (1952)).

See also [65, 66, 70, 281, 285, 288, 302, 1185, 1186]

B. Oxidation

953. Bogaty, H., Campbell, K. S., and Appel, W. D., **The oxidation of cellulose by ozone in small concentrations,** TEXTILE RESEARCH JOURNAL **22**, 81–3 (1952).

954. Bogaty, H., Campbell, K. S., and Appel, W. D., **Some observations on the evaporation of water from cellulose,** TEXTILE RESEARCH JOURNAL **22**, 75–81 (1952).

955. Caille, A., and Cuvelier, G., **Estimation of the degradation of linen by measuring the "solubility number",*** *Bull. inst. text. France,* No. 30, 221–8 (1952).

956. Kind, W., and Vollenbruck, H., **Determination of fiber degradation in linen yarn bleaching,*** *Textil-Praxis* **7**, 716–20 (1952).

957. Pinte, J., and Rochas, P., **The constitution and properties of rayons degraded by sodium hypochlorite,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 57–79 (in French).

958. Shinozaki, T., **Test of damage to fibers: I: Solubility of cotton fibers in sodium hydroxide solution,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 345–8 (1949) (*Chem. Abstracts* **46**, 4236d (1952)).

959. Shinozaki, T., **Test of damage to fibers: II: The solubility test,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 348–50 (1949) (*Chem. Abstracts* **46**, 4236e (1952)).

960. Winter, R., **Prevention of bleaching damages by control of the bleaching baths,*** *Z. ges. Textil-Ind.* **54**, 213–14 (1952).

961. Yelland, W. E. C., **"Degradation from weathering of tentage fabrics,"** Textile Series Report 40, U. S. Office of the Quartermaster General, 1951, 154 pp.

C. Effects of Light

962. Agster, A., **Dulling chemical fibers with titanium dioxide,*** *Melliand Textilber.* **33**, 739–43 (1952).

963. Ashton, D., and Probert, M. E., **A simple technique for investigating the effect of humidity on the fading and degradation of dyed fabrics by sunlight, and some observations on dyed cotton,** *Shirley Inst. Mem.* **26**, 41–51 (1952); *J. Text. Inst.* **44**, T1–11 (1953).

964. Dean, J. D., Fleming, C. M., and O'Connor, R. T., **Effects of unfiltered carbon arc light in accelerated weathering of cotton and other textiles,** TEXTILE RESEARCH JOURNAL **22**, 609–16 (1952).

965. Henk, H.-J., **The effect of light on textile fibers,*** *Melliand Textilber.* **33**, 488–91 (1952).

966. Joshi, G. D., and Nabar, G. M., **Accelerated oxidation of cotton cellulose in presence of reducing substances: III,** *Proc. Indian Acad. Sci.* **34**, 101–20 (1951).

967. Kothari, C. B., and Nabar, G. M., **Action of light on vat-dyed cellulose,** *J. Soc. Dyers and Colourists* **68**, 66–7 (1952) (Letter to the Editor).

968. Kujirai, C., **Photochemistry of cellulose: I,*** *Bull. Inst. Chem. Research, Kyoto Univ.* **23**, 35–44 (1950) (*Chem. Abstracts* **47**, 1929g (1953)).

969. Pinte, J., and Rochas, P., **Note on a particular case of photochemical degradation of delustered viscose rayon,*** *Bull. inst. text. France,* No. 31, 9–17 (1952).

970. Saeman, J. F., Millett, M. A., and Lawton, E. J., **Effect of high-energy cathode rays on cellulose,** *Ind. Eng. Chem.* **44**, 2848–52 (1952).

971. Schaeffer, A., **The effect of light on vat-dyed cellulose fibers,*** *SVF Fachorgan Textilveredl.* **6**, 37–47 (1951) (*Chem. Abstracts* **46**, 4798g (1952)).

972. Schwen, G., **The loss in strength produced by light and laundering on bright and titanium dioxide-delustered rayon, and the influence of titanium dioxide-delustering on the light fastness of dyestuffs,*** *Melliand Textilber.* **33**, 522–5 (1952).

973. Sippel, A., **How can damage to textiles by sunlight be prevented?*** *Textil-Praxis* **7**, 220–3 (1952).

974. Sippel, A., **The photochemistry of textile fibers: A path to fiber research and improvement,*** *Faserforsch. u. Textiltech.* **3**, 211–13 (1952).

975. Sippel, A., **The photolysis of textile fibers and fiber fine-structure,*** *Kolloid-Z.* **127**, 79–82 (1952).

976. Sippel, A., **The theory of photolysis of textile fibers,*** *Melliand Textilber.* **33**, 645–9 (1952).

See also [131, 543, 690]

D. Moth Damage and Mothproofing

977. Day, M. F., **Studies on the digestion of wool by insects: I: Microscopy of digestion of wool clothes moth larvae (*Tineola bisselliella*),** *Australian J. Sci. Research* **B4**, 42–8 (1951).

978. Day, M. F., **Studies on the digestion of wool by insects: III: A comparison between the tracheation of the midgut of *Tineola* larvae and that of other insect tissues,** *Australian J. Sci. Research* **B4**, 64–74 (1951).

979. Hartley, R. S., Elsworth, F. F., Midgley, P. G., and Barritt, J., **Estimation of mothproofing agents in wool: Quantitative estimation of Eulan CN, Mitin FF, and Lanoc CN in wool,** *J. Soc. Dyers and Colourists* **68**, 171–5 (1952).

980. Horigan, F. D., and Sage, C. R., **"Mothproofing agents,"** Bibliographic Series No. 15, Philadelphia, U. S. Quartermaster Research and Development Laboratories, 1950, 44 pp.

DETERIORATION OF MATERIALS

981. Laibach, E., **Moths and moth-proofing,*** *Melliand Textilber.* **33**, 324–7 (1952).

982. Meeuse, A. D. J., **Practical application of different types of insecticides,*** *Bull. inst. text. France*, No. 30, 373–8 (1952).

983. Powning, R. F., Day, M. F., and Irzykiewicz, H., **Studies on the digestion of wool by insects: II: The properties of some insect proteinases,** *Australian J. Sci. Research* **B4**, 49–63 (1951).

984. Snowdon, J. J., and Petrillo, V. C., **Improved distillation assembly for determining fluorine in textiles,** *Chemist Analyst* **40**, 87–9 (1952).

985. Wälchli, O., and Zinkernagel, R., **Determination of the beetle resistance of woolen textiles by test method SNV 95902,*** *Textil-Rundschau* **7**, 105–13 (1952).

986. Waterhouse, D. F., **Detoxifying mechanisms in clothes moth larvae,** *Nature* **169**, 550 (1952) (Letter to the Editor).

987. Waterhouse, D. F., **Studies on the digestion of wool by insects: IV: Absorption and elimination of metals by lepidopterous larvae, with special reference to the clothes moth, *Tineola bisselliella,*** *Australian J. Sci. Research* **B5**, 143–68 (1952).

988. Waterhouse, D. F., **Studies on the digestion of wool by insects: V: The goblet cells in the midgut of larvae of the clothes moth (*Tineola bisselliello*) and other *Lepidoptera,*** *Australian J. Sci. Research* **B5**, 169–77 (1952).

989. Waterhouse, D. F., **Studies on the digestion of wool by insects: VI: The pH and oxidation-reduction potential of the alimentary canal of the clothes moth larva (*Tineola bi selliella*),** *Australian J. Sci. Research* **B5**, 178–88 (1952).

990. Zinkernagel, R., **Susceptibility of alpaca wool to attack by moth larvae,*** *SVF Fachorgan Textilveredl.* **6**, 299–303 (1951) (*J. Text. Inst.* **43**, A941 (1952)).

See also [509–523, 1185, 1186]

VIII. DETERGENCY AND SURFACE-ACTIVE AGENTS

A. Detergency

1. General

991. Aida, G., and Kasai, T., **Isoelectric washing of wool: I: Physicochemical experiments on wool washing with new detergents, especially the influence of pH on the washing capacity,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 165–70 (1951) (*Chem. Abstracts* **46**, 6411h (1952)).

992. Aida, G., and Kasai, T., **Isoelectric washing of wool: II: Influence of concentration on the washing capacity,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 170–2 (1951) (*Chem. Abstracts* **46**, 6411i (1952)).

993. Barail, L. C., **Toxicity of soap and detergents,** *Soap Sanit. Chemicals* **28**, No. 12, 48–51, 77 (1952) (*Chem. Abstracts* **47**, 1954d (1953)).

994. Furry, M. S., and O'Brien, E. M., **The cleaning efficiency of detergents and washing methods in laundering wool,** *Am. Dyestuff Reptr.* **41**, 861–2 (1952).

995. Kling, W., and Lange, H., **The electrophoretic properties of pigment particles in detergent solutions,*** *Kolloid-Z.* **127**, 19–27 (1952).

996. Leonard, E. A., **Laboratory performance test for detergents in continuous wool scouring,** *Am. Soc. Testing Materials, Papers on Evaluation of Soaps and Detergents, Spec. Tech. Pub.* No. 115, 13–17 (1951) (*Chem. Abstracts* **46**, 7348a (1952)).

997. Lindner, K., **Fiber-protecting detergents and detergent raw materials,*** *Seifen-Öle-Fette-Wachse* **77**, 612–16 (1951) (*Chem. Abstracts* **46**, 11719h (1952)).

998. Mack, P. B., Balog, J. A., and Jordan, M. N., **A comparative study of sonic and mechanical home washers: I: Strength and dimensional changes,** TEXTILE RESEARCH JOURNAL **22**, 30–42 (1952).

999. von Segesser, A., and Stüpel, H., **Washing experiments on artificially soiled nylon fabric,*** *Textil-Rundschau* **7**, 93–8 (1952).

1000. Snell, F. D., *et al.*, **Lectures of the 1952 short course on soap and synthetic detergents,** *J. Am. Oil Chemists' Soc.* **29**, 481–590 (1952) (*Chem. Abstracts* **47**, 893c (1953)).

1001. Sperry, W. A., **Detergents and their influence on sewage treatment,** *Sewage and Ind. Wastes* **23**, 1469–76 (1951) (*Chem. Abstracts* **46**, 2210h (1952)).

1002. Stevenson, D. G., **A microscopic study of oiled textile fibres immersed in aqueous media: II: Secondary droplets,** *J. Text. Inst.* **43**, T112–18 (1952).

1003. Stevenson, D. G., **The role of foam in detergent action,** *J. Soc. Dyers and Colourists* **68**, 57–9 (1952).

1004. Stüpel, H., **Importance of hydrocarbon chemistry in the synthetic detergent industry,*** *Erdöl u. Kohle* **4**, 687–92 (1951) (*Chem. Abstracts* **46**, 2823g (1952)).

1005. Stüpel, H., **Laboratory laundering with synthetic detergents and other laundering agents: II: Relation between detergency and water hardness,*** *Fette u. Seifen* **54**, 321–4 (1952) (*Chem. Abstracts* **46**, 8880a (1952)).

1006. Stüpel, H., **New results and problems in the field of synthetic detergents,*** *Melliand Textilber.* **33**, 1025–8, 1101–5 (1952).

1007. Stüpel, H., **Surface-active agents and detergents,*** *SVF Fachorgan Textilveredl.* **7**, 154–7, 219–24 (1952) (*Chem. Abstracts* **46**, 10647h (1952)).

1008. Vallée, J., **Does a relationship exist between foaming power and detergency?*** *Teintex* **17**, 235, 237, 239 (1952).

See also [1456]

2. Measurement

1009. Armbruster, E. H., and Ridenour, G. M., **Detergency measurement,** *Soap Sanit. Chemicals* **28**, No. 6, 83, 85, 87, 89 (1952).

1010. Harris, J. C., **Detergent evaluation: III: Adjustment of Terg-O-Tometer and Launderometer wash test methods to produce comparable soil-removal data,** *J. Am. Oil Chemists' Soc.* **29**, 110–13 (1952) (*Chem. Abstracts* **46**, 4254h (1952)).

1011. Lambert, J. M., **Present trends in cotton-detergency testing,** *Proc. Chem. Specialties Mfrs. Assoc.*, Dec. **1951**, 103–6 (*Chem. Abstracts* **46**, 10647h (1952)).

1012. Machemer, H., **Whiteness measurement [of test-washed fabric],*** *Fette u. Seifen* **54**, 324–33 (1952) (*Chem. Abstracts* **47**, 1410b (1953)).

1013. Mitchell, R. B., **Evaluation of soiled test pieces,** *Am. Soc. Testing Materials, Papers on Evaluation of Soaps and Detergents, Spec. Tech. Pub.* No. 115, 3–8 (1951) (*Chem. Abstracts* **46**, 7347e (1952)).

1014. Peukert, L., **Testing of laundering compounds,*** *Fette u. Seifen* **54**, 453–5 (1952) (*Chem. Abstracts* **47**, 894f (1953)).

1015. Ringeissen, M., **Measurement of detergency,*** *Oléagineux* **6**, 345–50 (1951) (*Chem. Abstracts* **46**, 2823e (1952)).

1016. Schwarz, E. W. K., Leonard, E. A., *et al.*, **Measurement of fabric soiling,** *Am. Dyestuff Reptr.* **41**, P322–40 (1952).

1017. Wagg, R. E., **A new soiling mixture for use in detergency evaluation,** *J. Text. Inst.* **43**, T515–16 (1952) (Letter to the Editor).

3. *Builders*

1018. Hader, R. N., Waldeck, W. F., and Smith, F. W., **Carboxymethylcellulose,** *Ind. Eng. Chem.* **44**, 2803–12 (1952).

1019. Jarrell, J. G., and Trost, H. B., **CMC: An aid to washability,** *Soap. Sanit. Chemicals* **28**, No. 7, 40–3, 155; No. 8, 50–2, 163 (1952).

1020. Pollok, F. J., **Sodium carboxymethylcellulose as a detergent aid,** *Soap, Perfumery & Cosmetics* **24**, 991–5 (1951).

1021. Stüpel, H., **Experiments on the detergency effectiveness of soap-phosphate combinations,*** *Textil-Praxis* **7**, 231–4 (1952).

1022. Stüpel, H., **Washing experiments on artificially soiled wool with various synthetic raw products in combination with anhydrous phosphates,*** *Textil-Praxis* **7**, 723–5 (1952).

1023. Watanabe, T., **Washing agents: I: Some properties of the sodium alginate added to soap solutions,*** *J. Chem. Soc. Japan*, Ind. Chem. Sect., **52**, 308–9 (1949) (*Chem. Abstracts* **46**, 7347d (1952)).

See also [1449]

4. *Micelle Formation*

1024. Brown, A. S., Robinson, R. U., Sirois, E. H., Thibault, H. G., McNeill, W., and Tofias, A., **Critical micelle concentrations by a bubble pressure method,** *J. Phys. Chem.* **56**, 701–5 (1952).

1025. Klevens, H. B., **Solubility effects and order-disorder states in detergent solutions,*** *Kolloid-Z.* **128**, 61–7 (1952).

1026. Mankowich, A. M., **Selection of surface active agents for detergent applications: Suspending power and micellar solubilization,** *Ind. Eng. Chem.* **44**, 1151–9 (1952).

1027. Ôshika, Y., **The critical micelle concentration of a soap solution,*** *Busseiron Kenkyû* (Researches on Chem. Phys.) **44**, 30–5 (1951) (*Chem. Abstracts* **46**, 1842g (1952)).

1028. Thiele, H., **Change in form of soap micelles,*** *Kolloid-Z.* **125**, 31–2 (1952).

5. *Adsorption*

1029. Fessler, W. A., **Measurement of the adsorption of anion-active detergents by materials commonly washed,** *Am. Soc. Testing Materials, Papers on Evaluation of Soaps and Detergents, Spec. Tech. Pub.* No. 115, 9–12 (1951) (*Chem. Abstracts* **46**, 7347g (1952)).

1030. Flett, L. H., Hoyt, L. F., and Walter, J., **Quantitative data on the adsorption of a detergent by cotton sheeting under textile processing conditions,** *Am. Dyestuff Reptr.* **41**, P139–43 (1952).

1031. Hart, W. J., and Compton, J., **Soiling and soil retention in textile fibers: Primary deposition of grease-free carbon black on chopped cotton fibers,** *Ind. Eng. Chem.* **44**, 1135–41 (1952).

1032. Judson, C. M., Lerew, A. A., Dixon, J. K., and Salley, D. J., **The surface adsorption of small ions in solutions of surface-active agents,** *J. Chem. Phys.* **20**, 519–20 (1952) (Letter to the Editor).

1033. Madsen, T., **Action of carboxymethylcellulose (CMC) as a detergent,*** *Tids. Textilteknik* **10**, 243–5 (1952).

1034. Meader, A. L., Jr., and Fries, B. A., **Adsorption in the detergent process,** *Ind. Eng. Chem.* **44**, 1636–48 (1952).

1035. Okamura, I., **Soiling of textiles,** *Teijin Times* **22**, No. 2, 3–4 (1952) (in English) (*Chem. Abstracts* **46**, 4806f (1952)).

1036. Wagg, R. E., **Deposition of soiling matter from some detergent systems: 1: Aqueous systems,** *J. Text. Inst.* **43**, T325–30 (1952).

1037. Wagg, R. E., **Deposition of soiling matter from some detergent systems: 2: Non-aqueous systems,** *J. Text. Inst.* **43**, T331–7 (1952).

1038. Weatherburn, A. S., **The sorption of surface active compounds by textile fibres,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 36–9.

1039. Weatherburn, A. S., and Bayley, C. H., **The sorption of synthetic surface-active compounds by textile fibers,** TEXTILE RESEARCH JOURNAL **22**, 797–804 (1952).

B. *Behavior of Fabrics in Laundering and Dry Cleaning*

1040. Anon., **Stability of artificial fibers in dry cleaning,*** *Teintex* **17**, 497 (1952).

1041. Barnabe, N., **Washing tests on fabrics of cotton and cotton-rayon staple,*** *Rayonne et fibres synthét.* **7**, No. 3, 19–24 (1951).

1042. Brewer, G. E. F., **The relationship between the graying of textiles and the frictional electricity generated in organic solvent systems,** *J. Am. Oil Chemists' Soc.* **29**, 218–19 (1952) (*Chem. Abstracts* **46**, 7334h (1952)).

1043. Furry, M. S., and O'Brien, E. M., **The laundering of wool: Effect of detergents and washing methods on fabric properties,** *Am. Dyestuff Reptr.* **41**, 763–9 (1952).

1044. Harris Research Laboratory and Textile Finishing Research Laboratory, **"Effect of construction on the laundering shrinkage of knitted woolens,"** Textile Series Report 66, U. S. Office of the Quartermaster General, 1951, 16 pp.

1045. Johnson, A. E., **Fabric behavior in dry cleaning: Velvets and velveteens,** *Modern Textiles Mag.* **33**, No. 10, 34, 70 (1952).

1046. Knowles, D. C., Jr., Berch, J., and Schwartz, A. M., **The deposition of lime soap on fabrics during washing,** *J. Am. Oil Chemists' Soc.* **29**, 158–61 (1952) (*Chem. Abstracts* **46**, 5868f (1952)).

1047. Stevens, H. T., and Browning, S. M., **Shrinkage of cotton fabrics,** *Rayon and Synthetic Texts.* **33**, No. 7, 62–4, 69 (1952).

1048. Urusova, T. P., **Absorption of ethylene dichloride by clothing,*** *Gigiena i Sanit.* **16**, No. 12, 50–1 (1951) (*Chem. Abstracts* **46**, 3287e (1952)).

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1049. Vollenbruck, H., **The course of fiber degradation during washing: I: Cotton,*** *Melliand Textilber.* **33**, 856–9 (1952).

1050. Vollenbruck, H., **The course of fiber degradation during washing: II: Rayon staple,*** *Melliand Textilber.* **33**, 1105–7 (1952).

1051. Wills, C., **Fabric shrinkage and launderability,** *Can. Text. J.* **69**, No. 4, 55–7 (1952).

See also [997, 1299, 1833, 1834]

C. Wetting

1052. Bartell, F. E., and Ray, B. R., **Wetting characteristics of cellulose derivatives: I: Contact angles formed by water and by organic liquids,** *J. Am. Chem. Soc.* **74**, 778–83 (1952).

1053. Gobel, E. F., Teixeira-Mendes, M. A., and Taranto, G., **Test for wetting properties,*** *Rev. quim. ind. (Rio de Janeiro)* **19**, No. 224, 16–19 (1950) (*J. Text. Inst.* **43**, A255 (1952)).

1054. Gruntfest, I. J., **Wetting of textiles,** *Am. Soc. Testing Materials, Papers on Evaluation of Soaps and Detergents, Spec. Tech. Pub.*, No. 115, 43–51 (1951) (*Chem. Abstracts* **46**, 5851f (1952)).

1055. Knafo, G., Reutenauer, G., and Rosano, L., **Study of wetting power from a physical chemistry point of view,*** *Teintex* **17**, 786, 789, 791, 793, 795, 797 (1952).

1056. MacLellan, A. G., **A statistical-mechanical theory of surface tension,** *Proc. Roy. Soc.* (London) **A213**, 274–84 (1952).

1057. Preston, J. M., and Nimkar, M. V., **Capillary phenomena in assemblies of fibres,** *J. Text. Inst.* **43**, T402–22 (1952).

1058. Reutenauer, G., Sisley, J. P., and Dupin, S., **A new method of determination of wetting power,** *Am. Dyestuff Reptr.* **41**, P25–30 (1952).

1059. Wolfrom, R. E., and Nuessle, A. C., **Some observations on the wetting of greige cotton,** TEXTILE RESEARCH JOURNAL **22**, 246–53 (1952).

See also [1456]

D. Analysis of Surface-Active Agents

1060. Edwards, G. R., Ewers, W. E., and Mansfield, W. W., **Quantitative determination of sodium cetyl sulphate in its solution in water,** *Analyst* **77**, 205–7 (1952).

1061. Gauthier, B., and Mazau, L., **Analysis of synthetic detergents,*** *Ann. pharm. franç.* **9**, 678–90 (1951) (*Chem. Abstracts* **46**, 4819d (1952)).

1062. Stoves, J. L., **Laboratory methods in the wool textile industry: III: Analysis of soaps,** *Textile Inds. and Fibres* **13**, 317–18 (1952).

1063. Stüpel, H., **Quantitative determination of detergent substances,*** *Chem.-Ztg.* **76**, 252–6 (1952).

See also [73, 993]

E. Miscellaneous

1064. Ermolaeva, A. A., **New surface-active agents,*** *Tekstil. Prom.* **9**, No. 4, 25–8 (1949) (*Chem. Abstracts* **46**, 4240f (1952)).

1065. Marcou, L., **Non-ionic surface-active agents,*** *Teintex* **17**, 421–2, 425, 427–8, 431, 433–4, 437, 439, 441, 443 (1952).

1066. Martin, R. L., **"Reclaiming dry cleaning solvents,"** Bibliographic Series No. 16, Philadelphia, U. S. Quartermaster Research and Development Laboratories, 1950, 37 pp.

1067. Trinchieri, G., **Ethylene oxide derivatives and their uses in the textile industry,** *Am. Dyestuff Reptr.* **41**, 729–32, 751–2 (1952).

IX. TEST METHODS AND APPARATUS

A. Geometrical and Mechanical Properties

1. Single Fibers

(a) Length

1068. Anon., **The measurement of wool fibre length,** *Wool Science Rev.*, No. 9, 15–29 (1952).

1069. Caban, T., **Methods for determination of the staple length of synthetic fibers of the cotton type,*** *Prace Głównego Inst. Włókiennictwa* **1**, 15–36 (1951) (*Faserforsch. u. Textiltech.* **3**, 292 (1952)).

1070. Committee for the Development of Testing Methods for Fibrous Materials, **Determination of the length of synthetic fiber staple with the comb-stapler* (FaChemFa Z Tex 7)** 1951 Edition, *Melliand Textilber.* **33**, 239–40 (1952).

1071. Huberty, A., **A note on the measurement of wool fibre length by the "three clamps" method,** *J. Text. Inst.* **43**, P153–55 (1952).

1072. Hummel, G., **Methods for measuring the length change of textile fibers,*** *Textil-Praxis* **7**, 813–15 (1952).

1073. Monfort, F., **Measurement of the length of wool in a top by the wool merchant: II: Various conceptions of the average length of fibers in a top,*** *Bull. inst. text. France*, No. 33, 41–53 (1952).

1074. Röder, H. L., **Determination of fiber length distribution by measuring individual fibers,*** *Rayon Rev.* **6**, 102–8 (1952) (*J. Text. Inst.* **43**, A830 (1952)).

1075. Tallant, J. D., **Use of a servo system for automatic operation of the Fibrograph,** TEXTILE RESEARCH JOURNAL **22**, 617–19 (1952).

1076. Waggett, G., **A method for determining the fibre length distribution of rayon staple tops,** *J. Text. Inst.* **43**, T188–95 (1952).

1077. Wilson, L. T., and Roberts, N. F., **Physical analysis of the fleece of sheep for biological purposes: III: A means of measurement of the fibre-length distribution of fleece wool,** *Australian J. Agr. Research* **2**, 205–19 (1951) (*J. Text. Inst.* **43**, A114 (1952)).

1078. Wool Industries Research Association, **Measurement of fibre length,** *Textile Manufacturer* **78**, 206–7 (1952).

See also [335]

(b) Diameter

1079. Anon., **The measurement of wool fibre diameter,** *Wool Science Rev.*, No. 8, 33–60 (1952).

1080. Bobeth, W., **The problem of thickness measurement on glass fibers,*** *Faserforsch. u. Textiltech.* **3**, 19–27 (1952).

1081. Bobeth, W., **Thickness measurements in air on filaments of circular cross-section,*** *Z. ges. Textil-Ind.* **54**, 189–92 (1952).

1082. de Cuenca, C. L., **A microtome for use in measuring fineness of wool fibers by transverse sections,** *J. Text. Inst.* **43**, P729–33 (1952); *Bull. inst. text. France*, No. 33, 59–62 + 2 plates (1952).

1083. Dart, S. L., and Peterson, L. E., **An improved vibroscope,** TEXTILE RESEARCH JOURNAL **22**, 819–22 (1952); part of this paper appeared in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 405–8 (in English).

1084. Denton, P., **An interference micrometer for diameter measurement of textile filaments in moisture-controlled atmospheres,** *J. Sci. Instruments* **29**, 55–7 (1952).

1085. Montgomery, D. J., and Milloway, W. T., **The vibroscopic method for determination of fiber cross-sectional area,** TEXTILE RESEARCH JOURNAL **22**, 729–35 (1952).

1086. Wilson, L. T., **Physical analysis of the fleece of sheep for biological purposes: I: Actual and apparent cross-sectional areas of a staple fleece wool under lateral compression,** *Australian J. Agr. Research* **2**, 181–94 (1951) (*J. Text. Inst.* **43**, A113 (1952)).

1087. Wilson, L. T., **Physical analysis of the fleece of sheep for biological purposes: II: Estimation of the number and mean diameter of wool fibres from a cast of their cross-section,** *Australian J. Agr. Research* **2**, 195–204 (1951) (*J. Text. Inst.* **43**, A114 (1952)).

(c) *Mechanical Properties*

1088. Fujino, K., and Kawai, H., **Solid viscosity of textile materials as a function of temperature,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 79–82, 239–43 (1950) (*Chem. Abstracts* **46**, 5849d, 6392i (1952)).

1089. Hillier, K. W., **A vibrating cantilever method for the investigation of the dynamic elasticity of high polymers,** *Proc. Phys. Soc.* (London) **B64**, 998–1005 (1951).

1090. Kubu, E. T., **The stress relaxation of fibrous materials: I: Instrumentation and preliminary results,** TEXTILE RESEARCH JOURNAL **22**, 765–77 (1952).

1091. McLoughlin, J. R., **A recording stress relaxometer,** *Rev. Sci. Instruments* **23**, 459–62 (1952).

1092. Okamura, I., **Elastic properties of textile fibers,** *Teijin Times* **21**, No. 10, 2–5 (1951) (in English).

1093. Toner, R. K., **A modified Pressley test,** *Textile Inds.* **116**, No. 9, 176–8 (1952).

(d) *Optical and Other Properties*

1094. Bozza, G., **The physics of the textile fiber,*** *Riv. tessile* **7**, 67–70, 207–15 (1952) (*Text. Tech. Digest* **9**, 1107 (1952)).

1095. Faust, R. C., **An interferometric method of studying local variations in the refractive indices of a solid,** *Proc. Phys. Soc.* (London) **B65**, 48–62 (1952).

1096. Flück, H. M., **Limiting fiber density,*** *Textil-Rundschau* **7**, 65–70 (1952).

1097. Gaus, G. E., and Larrison, J. E., **"A mechanical cotton fiber blender for use in fiber testing laboratories,"** Washington, D. C., U. S. Dept. of Agriculture, Production and Marketing Administration, Cotton Branch, Aug. 1951, 24 pp.

1098. Heyn, A. N. J., **Observations of the birefringence and refractive index of synthetic fibers with special reference to their identification,** TEXTILE RESEARCH JOURNAL **22**, 513–22 (1952).

1099. Lindsley, C. H., **The use of density gradient columns for the determination of specific gravity,** TEXTILE RESEARCH JOURNAL **22**, 287 (1952) (Letter to the Editor).

1100. de Vries, H., **Double refraction measurement of fibers,** TEXTILE RESEARCH JOURNAL **22**, 619–20 (1952) (Letter to the Editor).

See also [177, 181]

2. *Fiber Assemblies*

(a) *Mechanical Properties of Yarn*

1101. Borodovskii, M. S., **The strength of textile materials,*** *Tekstil. Prom.* **11**, No. 12, 34–7 (1951); **12**, No. 2, 31–4 (1952); *Faserforsch. u. Textiltech.* **3**, 146–54 (1952).

1102. Breazeale, F. B., and Irvin, H. D., **An automatic yarn load-elongation recorder,** TEXTILE RESEARCH JOURNAL **22**, 549–52 (1952).

1103. Hajmasy, T., **Fatigue of cotton yarn in repeated straining,*** *Magyar Textiltech.* **5**, 130–3, 170–4 (1952) (*Faserforsch. u. Textiltech.* **3**, 511 (1952)).

1104. van Lingen, H., **Electronic dynamometers in modern textile research?*** *De Tex* **10**, 929–40 (1951) (*J. Text. Inst.* **43**, A920 (1952)).

1105. Nistico, F., Sprague, B. S., and Work, R. W., **A high-speed recording yarn tensiometer,** TEXTILE RESEARCH JOURNAL **22**, 99–110 (1952).

1106. van Overbeke, M., **Determination of breaking load and extension of a wool yarn,*** *Bull. trimestr., Chamb. comm. Roubaix*, No. 12, 26–9 (1951).

1107. Schenkel, E., **Yarn tenacity: Measured as single end and skein breaking values,*** *Textil-Praxis* **7**, 875–8 (1952).

1108. Sproule, D. O., **Measurement of yarn weight and moisture content by transverse vibration,** *J. Text. Inst.* **43**, T455–62 (1952).

1109. Vasil'ev, I. D., **The influence of inner stresses on the physical-mechanical processes of twisted products,*** *Tekstil. Prom.* **12**, No. 4, 24–6 (1952) (*Faserforsch. u. Textiltech.* **3**, 340 (1952)).

1110. de Vries, H., **The significance of the load-elongation curves for yarns,*** *Rayon Rev.* **6**, 145–51 (1952) (*J. Text. Inst.* **43**, A928 (1952)).

1111. Wegener, W., **Testing of yarns under alternating stress superimposed on a constant rate of loading,*** *Melliand Textilber.* **33**, 338–42, 656–60, 1038–40, 1119–21 (1952).

1112. Wegener, W., **Wegener yarn testing apparatus for simultaneous recording of the time-extension or the load-extension curve and its first differential coefficient,*** *Arch. tech. Messen* **181**, 87–8 (1952) (*J. Text. Inst.* **43**, A655 (1952)).

1113. Wegener, W., **Yarn testing apparatus for the photometric determination of elongation and change in elongation,*** *Arch. tech. Messen* **181**, 153–4 (1952) (*J. Text. Inst.* **44**, A47 (1953)).

(b) *Mechanical Properties of Fabric*

1114. Anderson, S. L., **A method of obtaining stress-strain relations in nonisotropic sheet material under two-dimensional stress,** *Selected Govt. Research Repts.* (London) (Textiles and Their Testing) **4**, 11–18 (1949) (*Chem. Abstracts* **46**, 5850i (1952)).

1115. Anderson, S. L., **Tearing strength of plied fabrics,** *Selected Govt. Research Repts.* (London) (Textiles and Their Testing) **4**, 1–4 (1949) (*Chem. Abstracts* **46**, 5850g (1952)).

1116. Böhme, W., **The origin, scope, and procedure of wear testing,*** *Faserforsch. u. Textiltech.* **3**, 28–34 (1952).

TEST METHODS AND APPARATUS

1117. Brown, G. L., **Fabric testing machine, inclined plane type,** *J. Text. Inst.* **43**, T119–22 (1952).

1118. Dvornitskii, G. S., **Dynamometric testing of textile materials,*** *Tekstil. Prom.* **12**, No. 7, 43–4 (1952) (*Faserforsch. u. Textiltech.* **3**, 463 (1952)).

1119. Gunther, D. H., *et al.*, **Toward a simple means of judging hand,** *Am. Dyestuff Reptr.* **41**, P167–72 (1952).

1120. Holderer, H., **Considerations in testing air-porous impregnated fabrics,*** *Textil-Praxis* **7**, 228–30 (1952).

1121. Knopp, H., **The Sander wear-testing machine,*** *Melliand Textilber.* **33**, 237–8 (1952).

1122. Marti, A., **The I.T.F.-M. abrasion machine and the graphical presentation of progressive wear of fabrics,*** *Bull. inst. text. France*, No. 32, 9–18 (1952).

1123. van Overbeke, M., **Determination of the degree of feltability of knitted and woven wool fabrics,*** *Bull. trimestr., Chamb. comm. Roubaix*, No. 12, 5–8 (1951).

1124. Reese, H., **Strength testing of cotton fabrics after various finishing processes,*** *Melliand Textilber.* **33**, 770–4 (1952).

1125. Satlow, G., **Special textile testing processes,*** *Melliand Textilber.* **33**, 126–30, 232–4, 342–3 (1952).

1126. Schiefer, H. F., and Werntz, C. W., **Interpretation of tests for resistance to abrasion of textiles,** TEXTILE RESEARCH JOURNAL **22**, 1–12 (1952).

1127. Shaw, M. C., **Abradoflex—abrasion resistance tester,** *Textile Manufacturer* **78**, 252–5 (1952).

1128. Williams, B. H., and Richmond, W. H., **The technique of determining the tensile strength of woven glass fabric,** *J. Text. Inst.* **43**, T69–75 (1952) (Letter to the Editor).

1129. Winkler, F., **On the theory of the bursting strength of foils,*** *Faserforsch. u. Textiltech.* **3**, 449–58 (1952).

See also [1320, 1918, 1921, 1923, 1926]

(c) *Other Fiber Assemblies*

1130. Kramer, J., **Some new methods of testing sliver,*** *Rayonne et fibres synthét.* **8**, No. 5, 63, 65, 67 (1952).

1131. Nitschke, G., **Determination of the neppiness of combed materials,*** *Faserforsch. u. Textiltech.* **3**, 95–105 (1952).

1132. Schlegel, W., **Evaluation of testing processes for scutcher laps,*** *Melliand Textilber.* **33**, 547 (1952).

1133. Waggett, G., **The tensile properties of card and drawframe slivers,** *J. Text. Inst.* **43**, T380–95 (1952).

See also [1219, 1231, 1235]

B. Chemical Tests

1. Identification of Fibers

1134. Cirr, H., **Quantitative microscopic determination of the blending proportions of different raw materials in finished goods,*** *Melliand Textilber.* **33**, 448–9 (1952).

1135. Evdokimova, N. IA., and Tikhonravova, O. P., **Simplified method of fiber determination in fabrics,*** *Tekstil. Prom.* **10**, No. 10, 20–5 (1950) (*Chem. Abstracts* **46**, 6392c (1952)).

1136. Fisher, D. C., and Roberts, E. D., **Analysis of staple fiber mixtures,** TEXTILE RESEARCH JOURNAL **22**, 509–12 (1952).

1137. de Hauss, J. L., **Photocolorimetric analytical methods and their possibilities,*** *Reyon Zellwolle u. Chemiefasern* **30**, 22–5 (1952).

1138. Koch, P.-A., **Fiber tables: Identification and separation of various types of man-made fibers,*** *Textil-Rundschau* **7**, 273–7 (1952).

1139. Ludewig, H., **The differentiation of Perlon and nylon,*** *Faserforsch. u. Textiltech.* **3**, 354–6 (1952).

1140. Müller, A., **Differentiation of synthetic fibers—particularly nylon and Perlon L or Grilon,*** *SVF Fachorgan Textilveredl.* **6**, 128–34 (1951) (*Chem. Abstracts* **46**, 4803b (1952)).

1141. Royer, G. L., **Identification of synthetic fibers by microscopical and dye staining techniques,** *Papers AATT* **8**, 32–40 (1952).

1142. Textile Institute Unification of Testing Methods Committee (General Technical Committee "C"), **Identification of textile materials,** *J. Text. Inst.* **42**, S25–114 (1951).

1143. Ulrich, H. M., **Identification of synthetic fibers alone and in mixtures with other fibers,*** *Textil-Praxis* **7**, 150–4, 211–15 (1952).

1144. Wilson, W. R., **A systematic scheme of fiber analysis by solvent action,** *Papers AATT* **8**, 29–31 (1952).

1145. Zill, H., **"Zillo-Test": The testing apparatus for synthetic fibers,*** *Melliand Textilber.* **33**, 453–4 (1952).

See also [1098]

2. Analysis of Fibrous Materials

1146. Brown, E. G., and Hayes, T. J., **The determination of iron in delustered rayon,** *Anal. Chim. Acta* **7**, 324–9 (1952) (in English).

1147. Brown, E. G., and Hayes, T. J., **The determination of small quantities of alginates in rayon finishes and on yarn,** *Analyst* **77**, 445–53 (1952).

1148. Gorshkov, P. V., **Evaluation of cloth damage in Aniline Black dyeing,*** *Ivanov. Nauch.-Issledovatel. Inst. Khlopchatobumazh. Prom., Nauch.-Issledovatel. Trudy* **18**, 119–22 (1951) (*Chem. Abstracts* **46**, 9850c (1952)).

1149. Martens, R. I., and Githens, R. E., Sr., **Small amounts of copper in dyes and rubber chemicals: Colorimetric determination with zinc dibenzyldithiocarbamate,** *Anal. Chem.* **24**, 991–3 (1952).

1150. Meyer, H., **Experience with fat determination on textiles,*** *Faserforsch. u. Textiltech.* **3**, 45–58 (1952).

1151. Nitschke, G., **A study of the determination of residual fat in scoured wool and top with the help of rapid methods, especially the refractometer method,*** *Faserforsch. u. Textiltech.* **3**, 302–10 (1952).

1152. Rath, H., Nawrath, G., and Schönpflug, E., **Detection of polyacrylates in finishes, sizes, and fibers,*** *Melliand Textilber.* **33**, 636–9 (1952).

1153. Rostovtsev, V. E., and Maslennikova, Z. I., **Rapid determination of starch en masse and on cloth,*** *Ivanov. Nauch.-Issledovatel. Inst. Khlopchatobumazh. Prom., Nauch.-Issledovatel. Trudy* **18**, 109–14 (1951) (*Chem. Abstracts* **46**, 9474e (1952)).

1154. von Bergen, W., and Pfenninger, H., **New methods for determining the yield from grease wool,*** *Textil-Rundschau* **7**, 1–12 (1952).

1155. Wagner, H. G., **Trials for standardization of testing methods of textile auxiliaries: A method for rapid determination of the fat content of textiles,*** *Melliand Textilber.* **33**, 875–6 (1952).

See also [165–172, 979, 984, 1919, 1920, 1925]

3. *Analysis of Textile Auxiliaries*

1156. Agster, A. (editor), P. Heermann's **"Examination of dyehouse- and textile-chemicals,"** * 8th ed., Berlin, Springer-Verlag, 1951, 438 pp. (reviewed in *Kolloid-Z.* **125**, 177 (1952)).

1157. Atherton, E., **A photoelectric turbidimeter for particle size determination,** *J. Text. Inst.* **43**, T173–8 (1952).

1158. Atherton, E., and Peters, R. H., **Determination of the particle size of dispersed resins by two optical methods,** *J. Text. Inst.* **43**, T179–87 (1952).

1159. Barail, L. C., **Skin-irritation tests for the textile industry,** *Am. Dyestuff Reptr.* **41**, P136–8, P143 (1952).

1160. Belen'kii, L. I., and Kazanskaia, M. E., **New method for the analysis of hydrosulfite,*** *Tekstil. Prom.* **12**, No. 6, 35 (1952) (*J. Soc. Dyers and Colourists* **69**, 71 (1953)).

1161. Brown, E. G., **Qualitative detection of long-chain alkylpyridinium halides,** *Analyst* **77**, 211 (1952).

1162. Emery, A. J., Jr., and Stotz, E., **Paper chromatography for analysis of a dye mixture,** *Stain Technol.* **27**, 21–8 (1952).

1163. Kerr, T. J., **Here are your laboratory techniques for fabric coating,** *Textile World* **102**, No. 3, 149, 151, 236, 238, 240, 242, 244 (1952).

1164. Schneid, A. F., **Analysis of dyes for man-made fibers,** *Am. Dyestuff Reptr.* **41**, 565–72 (1952).

1165. Schönpflug, E., **Analysis of synthetic finishes,*** *Textil-Praxis* **7**, 897–902, 975–8 (1952).

1166. Schütte, T., **Trials for standardization of testing methods of textile auxiliaries: Procedure for previous testing of lubricants with regard to the degree to which they can be washed out,*** *Melliand Textilber.* **33**, 774–7 (1952).

1167. Schwen, G., **Control [testing] of textile auxiliaries,*** *Teintex* **17**, 755–6, 759, 761–2, 765, 767–8 (1952).

1168. Stewart, J. R., **Mill-made jig for dyeing tests,** *Textile Inds.* **116**, No. 4, 116–17 (1952).

4. *Determination of Moisture*

1169. Garin, A., **Factors influencing the determination of water in textiles,*** *Bull. inst. text. France,* No. 30, 13–35 (1952).

1170. Haslam, J., and Clasper, M., **The determination of water in nylon,** *Analyst* **77**, 413–15 (1952).

1171. Miehlich, W., **Moisture testing on tire cord,*** *Reyon Zellwolle u. Chemiefasern* **30**, 412–17 (1952).

1172. Sakagami, T., Ebata, T., Kaino, I., Tanaka, Y., and Takagishi, E., **Measurement of moisture of fabrics by the high-frequency dielectric constants: II,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 369–72 (1951) (*Chem. Abstracts* **46**, 6392g (1952)).

1173. Sakaguchi, T., Ebata, T., Kaino, I., Tanaka, Y., and Takagishi, E., **Measurement of moisture of fabrics by the high-frequency dielectric constants: III,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 491–4 (1951) (*Chem. Abstracts* **46**, 6392h (1952)).

See also [1108]

C. *Studies with Radiation*

1. *Microscopy and Photography*

1174. Baillie, Y., **Possibilties of the electron microscope in textile research and some preliminary results,*** *Bull. inst. text. France,* No. 30, 55–68 + 10 pp. figures (1952).

1175. Bedarff, H., **A new method of embedding textiles for the preparation of extremely thin sections,*** *Melliand Textilber.* **33**, 1044–5 (1952).

1176. Besse, M., **Adaptation of the phase contrast microscope to textile problems,*** *Bull. inst. text. France,* No. 30, 79–89 + 14 pp. figures (1952).

1177. Davis, S. J., **A method of repetitive longitudinal sectioning of cords and fabrics for microscopic examination,** TEXTILE RESEARCH JOURNAL **22**, 192–9 (1952).

1178. Dillmann, F., **The fiber cross-section in technology,*** *Reyon Zellwolle u. Chemiefasern* **30**, 632–7 (1952).

1179. Dillmann, F., **Macrophotography of fabrics, knit goods, and yarns,*** *Reyon Zellwolle u. Chemiefasern* **30**, 404–6 (1952).

1180. Herzog, A., **A new stereoscopic "Wippe" for low magnification,*** *Faserforsch. u. Textiltech.* **3**, 222–4 (1952).

1181. Huberty, A., **A discontinuous method of measuring the sectional variation (regularity) of slivers, rovings and yarns: "The plate micrometer,"** *J. Text. Inst.* **43**, P156–61 (1952).

1182. Makishima, K., **A new method of making cross sections of fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 183–5 (1950) (*Chem. Abstracts* **46**, 4802e (1952)).

1183. Meijberg, C., **Cross-sections of yarns,** *Rayon Rev.* **5**, 33–8 (1951) (English edition).

1184. Morehead, F. F., **The high-contrast (wide-field) electron microscope objective and fiber replicas,** TEXTILE RESEARCH JOURNAL **22**, 379–84 (1952).

1185. Stoves, J. L., **Laboratory methods in the wool textile industry: I: Fibre identification and detection of damage,** *Textile Inds. and Fibres* **13**, 148–51 (1952).

1186. Stoves, J. L., **Laboratory methods in the wool textile industry: II: Microscopical and biological examination,** *Textile Inds. and Fibres* **13**, 218–20 (1952).

2. *Spectrophotometry and Color*

1187. Belen'kii, L. I., and Kazanskaia, M. E., **Determination of the "whiteness" of textile materials,*** *Tekstil. Prom.* **11**, No. 10, 23–5 (1951) (*J. Soc. Dyers and Colourists* **68**, 108 (1952)).

1188. Caspar, E. C., **Determination of the whiteness of optically brightened textiles,*** *Melliand Textilber.* **33**, 518–21 (1952).

1189. Crawley, T. V., Jr., Towery, J. D., Power, B. K., and Hessler, L. E., **Now you can grade cotton with a laboratory instrument,** *Textile World* **102**, No. 9, 100–1, 335–6, 338–9 (1952).

1190. Ellinger, H. W., **The "Pulfrich Photometer" as luster-meter,*** *Melliand Textilber.* **33**, 1043–4 (1952).

1191. de Hauss, J. L., **Photoelectric examination of various synthetic fibers,*** *Reyon Zellwolle u. Chemiefasern* **30**, 248–51 (1952).

1192. Lange, P. W., and Stenius, A. S., **A microspectrophotometer equipped with photomultipliers,** *Rev. Sci. Instruments* **22**, 865–8 (1951).

TEST METHODS AND APPARATUS

1193. Scheibe, G., and Fauss, R., **Ultraviolet absorption of high polymers,*** *Kolloid-Z.* **125**, 139–49 (1952).

See also [1819–1832]

3. Nuclear Radiation and X-Rays

1194. Crompton, C. E., **The future of the radioisotope technique in textile technology,** *Papers AATT* **7**, 69–73 (1952).

1195. Guinier, A., **The possibilities of low-angle x-ray diffraction in the study of large molecules,*** *J. Polymer Sci.* **9**, 557–63 (1952) (in French).

1196. Krimm, S., and Stein, R. S., **An x-ray spectrometer for polymer studies,** *Rev. Sci. Instruments* **22**, 920–5 (1951).

1197. Legrand, C., **New x-ray diffraction camera for fibers,*** *J. Polymer Sci.* **8**, 337–43 (1952) (in French).

1198. Robson, A., **Radioactive tracer techniques and their application in industry,** *J. Soc. Dyers and Colourists* **68**, 7–11 (1952).

See also [173–220, 422–456, 1009, 1378, 1853]

D. Statistical Topics

1199. vanden Abeele, A. M., **Introduction to the calculation of variance estimates,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 471–81 (in French).

1200. Bainbridge, T. R., **T-test techniques,** *Modern Textiles Mag.* **33**, No. 10, 35, 80–2 (1952).

1201. Crain, C. M., and Hainey, M. F., **A simple device for finding the RMS value of recorded data,** *Rev. Sci. Instruments* **23**, 243–5 (1952).

1202. Evans, T. F., **Statistical considerations in fiber research,** in **"ASTM Standards on Textile Materials,"** Philadelphia, Am. Soc. Testing Materials, Oct. 1952, pp. 602–8.

1203. Graf, U., and Henning, H.-J., **The statistical comparison of scattering in textile investigations,*** *Textil-Praxis* **7**, 815–20 (1952).

1204. Pratt, H. L., **Are your testing results reliable?** *Textile Inds.* **116**, No. 4, 134–8 (1952).

1205. Reinfeld, N., **Grapho-analytical methods in evaluating series of experiments or observations,*** *Melliand Textilber.* **33**, 879–80, 961–2 (1952).

1206. Tanner, L., and Lerner, M., **Economic accumulation of variance data in connection with bulk sampling,** *Am. Soc. Testing Materials, Symposium on Bulk Sampling, Spec. Tech. Pub.* No. 114, 8–12 (1951) (*Chem. Abstracts* **46**, 11009h (1952)).

1207. Whitwell, J. C., **Estimating precision of textile instruments,** *Biometrics* **7**, 102–12 (1951).

1208. Winkler, F., **False conclusions drawn from distribution function,*** *Faserforsch. u. Textiltech.* **3**, 322–9 (1952).

E. Miscellaneous

1209. Bayes, A. W., **Universal yarn counting system: International discussions and the Textile Institute questionnaire,** *J. Text. Inst.* **43**, S26–30 (1952).

1210. Beckers, P., **Nomographs in the textile industry,*** *Melliand Textilber.* **33**, 446–8, 548–9, 651–5 (1952).

1211. Hermanne, L., **Note on a basis for a range of standard counts (reduced range),** *J. Text. Inst.* **43**, P162 (1952) (Letter to the Editor).

1212. Hill, F., **Constant temperature and humidity chamber,** *J. Text. Inst.* **43**, P252–3 (1952) (Letter to the Editor).

1213. Lopez-Amo, F., **Desiccation instead of conditioning,*** *Bull. inst. text. France*, No. 30, 69–73 (1952).

1214. Lopez-Amo, F., **A metric, decimal, direct system for the weight numbering of solids with constant cross-section,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 433–6 (in French).

1215. Martindale, J. G., and Angus, J., **A constant temperature and humidity room,** *J. Text. Inst.* **43**, P122–3 (1952) (Letter to the Editor).

1216. Wagner, E., **Modern test and measuring instruments for the textile industry,*** *Z. ges. Textil-Ind.* **54**, 483–91 (1952).

X. FIBER-YARN-FABRIC RELATIONSHIPS

A. Fiber Properties and Their Relation to Properties of Fiber Assemblies

1217. Galceran-Escobet, V., **Influence of fineness and length of wool fibers on yarn number,*** *Bull. inst. text. France*, No. 30, 213–20 (1952).

1218. Grant, J. N., **Fiber strength and yarn strength,** *Textile Inds.* **116**, No. 7, 96–7 (1952).

1219. Marth, C. T., Arthur, H. E., and Berkley, E. E., **Fiber fineness (Micronaire), neps in card web, and yarn appearance grades,** TEXTILE RESEARCH JOURNAL **22**, 561–6 (1952).

1220. Meredith, R., **Properties of textile materials: I: Tensile strength, breaking extension and stress-strain relations of fibres,** *J. Text. Inst.* **43**, P755–64 (1952).

1221. Meredith, R., **Properties of textile materials: II: Rigidity, stiffness, and crease-resistance of fibres,** *J. Text. Inst.* **43**, P785–92 (1952).

1222. Morton, W. E., and Yen, K. C., **The arrangement of fibres in Fibro yarns,** *J. Text. Inst.* **43**, T60–6 (1952).

1223. Morton, W. E., and Yen, K. C., **Fibre arrangement in cotton slivers and laps,** *J. Text. Inst.* **43**, T463–72 (1952).

1224. Olerup, H., **Calculation of the variance-length curve for an ideal sliver,** *J. Text. Inst.* **43**, P290–3 (1952); *Bull. inst. text. France*, No. 33, 63–6 (1952).

1225. Platt, M. M., Klein, W. G., and Hamburger, W. J., **The applied mechanics of yarn structures as influenced by yarn geometry and inherent fiber properties,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 483–98 (in English).

1226. Platt, M. M., Klein, W. G., and Hamburger, W. J., **"Factors affecting the translation of certain mechanical properties of cordage fibers into cordage yarns,"** Office of Naval Research, Technical Report No. 6 (Fabric Research Laboratories, Inc.), Jan. 1952, 39 pp.

1227. Platt, M. M., Klein, W. G., and Hamburger, W. J., **Mechanics of elastic performance of textile materials: IX: Factors affecting the translation of certain mechanical properties of cordage fibers into cordage yarns,** TEXTILE RESEARCH JOURNAL **22**, 641–67 (1952).

1228. Platt, M. M., Klein, W. G., and Hamburger, W. J., **Mechanics of elastic performance of textile materials: Supplement to Part IX,** TEXTILE RESEARCH JOURNAL **22**, 827–9 (1952) (Letter to the Editor).

1229. Schenkel, E., **The staple form and its characteristic value (variation coefficient V),*** *Textil-Praxis* **7**, 493–6 (1952).

1230. Vogler, G., **Measurement of fiber parallelism in slivers and rovings with Litty's "Parallex" tester,*** *Textil-Praxis* **7**, 863–7 (1952).

See also [1486]

B. Interfiber Friction and Its Effect on Drawing and Spinning

1231. Anderson, S. L., Cox, D. R., and Hardy, L. D., **Some rheological properties of twistless combed wool slivers,** *J. Text. Inst.* **43**, T362–79 (1952).

1232. Bradbury, E., and Reicher, A., **High friction of extracted continuous filament yarn on clean glass surfaces,** *J. Text. Inst.* **43**, T350–3 (1952) (Letter to the Editor).

1233. Gralén, N., **Friction between single fibres (with comments by K. R. Makinson),** *Proc. Roy. Soc.* (London) **A212**, 491–6 (1952).

1234. Guthrie, J. C., and Oliver, P. H., **Inter-fibre friction of viscose rayon,** *J. Text. Inst.* **43**, T579–94 (1952).

1235. Ishikawa, S., **Relation between the tensile strength and length of slivers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 199–202 (1949) (*Chem. Abstracts* **46**, 3283h (1952)).

1236. Kinoshita, S., **Physical properties of fibers: II: Irreversible deformation of assembled fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 159–62 (1949) (*Chem. Abstracts* **46**, 3283h (1952)).

1237. Postle, L. J., and Ingham, J., **The measurement of inter-fibre friction in slivers (with Appendix by D. R. Cox),** *J. Text. Inst.* **43**, T77–90 (1952).

1238. Röder, H. L., **On the behaviour of fibres as they glide,** in **"Symposium on the Physics of Fibrous Materials"** (collected papers), Arnhem, Holland, 1950, pp. 61–84.

1239. Viviani, E., and Graziano, L., **The friction of rayon filaments against different materials and against each other,*** *Rayonne et fibres synthét.* **8**, No. 1, 27–33 (1952).

1240. Wood, C., **Dynamic friction of viscose fibres,** *J. Text. Inst.* **43**, T338–49 (1952).

C. Regularity of Sliver, Roving, and Yarn

1241. Barella, A., **The influence of twist on the regularity of the apparent diameter of worsted yarns,** *J. Text. Inst.* **43**, P734–41 (1952).

1242. Barella, A., **Interlaboratory measurements of the apparent diameter of yarn with the Barella regularity meter,*** *Bull. inst. text. France*, No. 36, 33–40 (1952).

1243. Barella, A., **Twist-influential factor in the regularity of yarn,*** *Industrie textile* **69**, 315–18 (1952) (*J. Text. Inst.* **43**, A929 (1952)).

1244. Böhme, H., **The effect of uneven yarns in fabrics,*** *Textil- u. Faserstofftech.* **2**, 202–5 (1952) (*Faserforsch. u. Textiltech.* **3**, 464 (1952)).

1245. Breny, H., **Remarks on the article by H. Sulser on "Theoretical bases for determination of the unevenness of yarns"* (with comments by H. Sulser),** *Textil-Rundschau* **8**, 80–3 (1953).

1246. Casby, R. F., **Mills cooperate to set tentative unevenness standards,** *Textile World* **102**, No. 7, 98–9, 218, 220, 222 (1952).

1247. Chandler, N. H., **Average percent unevenness: We know what the term means,** *Textile World* **102**, No. 7, 96–7, 214, 216, 218 (1952).

1248. Enrick, N. L., **Calculating expected yarn uniformity,** *Rayon and Synthetic Texts.* **33**, No. 4, 52, 104 (1952).

1249. Fiori, L. A., and Oser, L. F., **The importance of correcting range values on the Uster uniformity tester,** *Textile Inds.* **116**, No. 1, 149, 151, 153, 169 (1952).

1250. Frederikse, W. A., **Drafting of wool fibers,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 81–90 (in Dutch).

1251. Gnedenko, B. V., **Relation between yarn evenness and the length of the tested sample,*** *Tekstil. Prom.* **12**, No. 3, 27–31 (1952) (*Faserforsch. u. Textiltech.* **3**, 246 (1952)).

1252. Goossens, L., **Analysis of yarn strength,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 409–31 (in French); *Rayonne et fibres synthét.* **8**, No. 4, 99–106; No. 5, 47–9, 51–5 (1952).

1253. von Grossman, O., Masing, W., and Schubert, C., **A process for the continuous measurement of the evenness of beater laps: II: Evaluation of the lap tester diagram,*** *Textil-Praxis* **7**, 103–6 (1952).

1254. Grüner, H., **A new optical process for testing the uniformity of moving yarns,*** *Faserforsch. u. Textiltech.* **3**, 182–4 (1952).

1255. Honegger, E., **Yarn evenness and its testing,*** *Tids. Textilteknik* **10**, 165–76 (1952).

1256. Klompé, F. H. A. M., Wiggers, B. G., and Bakker, A., **Estimations of uniformity of spun rayon yarn,** *Rayon Rev.* **5**, 52–60 (1951) (English edition).

1257. Köb, H., **Unevenness problems in the triple condenser spinning mill,*** *Textil-Praxis* **7**, 487–92, 580–3 (1952).

1258. Locher, H., **Use of electronic apparatus for determining the irregularity of the weight per unit length in slivers, rovings and threads,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 449–60 (in French).

1259. Meyer, W., **Uniformity of rayon staple yarns,*** *Rayonne et fibres synthét.* **8**, No. 2, 17–21 (1952).

1260. Mönch, R., **Studies of the usefulness of E. Herzog's apparatus for measuring yarn quality,*** *Textil- u. Faserstofftech.* **2**, 205–7 (1952) (*Faserforsch. u. Textiltech.* **3**, 463 (1952)).

1261. Natus, D., **A photoelectric evenness tester for running threads, yarns, and the like,*** *Faserforsch u. Textiltech.* **3**, 311–22 (1952).

1262. Nitschke, G., **The evenness of card slivers, rovings, and tops of staple rayon: I,*** *Faserforsch. u. Textiltech.* **3**, 400–11 (1952).

1263. Okamura, I., **Longitudinal heterogeneity of rayon yarn,** *Teijin Times* **22**, No. 8, 5–7 (1952) (in English).

1264. Palmer, W. M., **Measurement of yarn evenness,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 27–9.

1265. Picard, H. C., **The irregularity of slivers: II,** *J. Text. Inst.* **43**, T251–61 (1952).

FIBER-YARN-FABRIC RELATIONSHIPS

1266. Quintelier, G., **Interpretation of regularity measurements on slivers, rovings, and yarns,*** *Bull. inst. text. France*, No. 30, 37–53 (1952).

1267. Ragasol, F. T., **A new type of regularity meter for yarns,*** *Bull. inst. text. France*, No. 30, 75–8 + 5 pp. figures (1952).

1268. Ramanathan, N., **Study of the irregularity of the products of cotton spinning,** *Indian Text. J.* **62**, 734–7, 755 (1952).

1269. Reichenbach, G., **Experience with the "Uster" evenness tester in cotton spinning: II: Formulation of the optimal spinning plan,*** *Textil-Praxis* **7**, 335–9 (1952).

1270. Richter, C., **The unevenness of yarn and its effect in producing hosiery and knit goods,*** *Textil-Praxis* **7**, 134–7 (1952).

1271. Simpson, J., Landstreet, C. B., and Corley, J. R., **An evaluation of long- and short-term variation in sliver and roving,** TEXTILE RESEARCH JOURNAL **22**, 42–8 (1952).

1272. Sulser, H., **Theoretical bases for determination of the unevenness of yarns,*** *Textil-Rundschau* **7**, 464–77 (1952).

See also [1108, 1181, 1485, 1515]

D. Effect of Twist on Yarn

1273. Alexander, E., **Optimal twist in staple yarn,** TEXTILE RESEARCH JOURNAL **22**, 503–8 (1952).

1274. Alexander, F. J., and Sturley, C. H., **The influence of twist on the breaking load and breaking extension of continuous filament nylon yarns and monofils,** *J. Text. Inst.* **43**, P1–18 (1952).

1275. Barella, A., **Some interesting properties of the coefficient of twist in combed wool yarns,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 175–84 (in French).

1276. Hermanne, L., and Quintelier, G., **Fatigue of tire cords as a function of twist (with author's comment by C. B. Budd),** TEXTILE RESEARCH JOURNAL **22**, 95–7 (1952) (Letter to the Editor).

1277. Monfort, F., **Distribution of twist in combed wool yarns,*** *Bull. inst. text. France*, No. 33, 55–8 (1952).

1278. Nanjundayya, C., **Effects of twist on yarn strength with special reference to the estimation of the latter at different twist multipliers,** *Indian Text. J.* **62**, 681–8, 693 (1952).

1279. Sesini, O., **Torsion in yarns,*** *Riv. tessile* **7**, 61–4, 201–4 (1952) (*J. Text. Inst.* **43**, A928 (1952)).

1280. Tokita, N., **On the twisting effect for the Young's modulus and the internal friction of yarn,*** *Bull. Kobayasi Inst. Phys. Research* **1**, 176–80 (1951).

1281. Wiernsberger, J., **Predetermination of the twist and tenacity of cotton and rayon threads with respect to their use,*** *Textil-Praxis* **7**, 263–8 (1952).

See also [1243]

E. Other Properties of Yarn

1282. Backer, S., **The mechanics of bent yarns,** TEXTILE RESEARCH JOURNAL **22**, 668–81 (1952).

1283. Dickson, J. B., **All-fiber system meets needs of fabric engineering,** *Textile World* **102**, No. 10, 113–15, 243–4, 246, 248, 250 (1952).

1284. Doyle, P. J., **Some fundamental properties of hosiery yarns and their relation to the mechanical characteristics of knitted fabrics,** *J. Text. Inst.* **43**, P19–35 (1952).

1285. Koeb, H., **Practical applications of the theory of yarn breakage,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 393–403 (in French).

1286. Nitschke, G., **Structural faults in viscose staple and their effect on the quality of tops and yarns,*** *Textil- u. Faserstofftech.* **2**, 198–201 (1952) (*Faserforsch. u. Textiltech.* **3**, 464 (1952)).

1287. Sen, K. R., **Analytical study of hairiness of yarn,** *Indian Text. J.* **62**, 300–4 (1952).

1288. Webb, R. W., and Richardson, H. B., **"Fiber measurements of second-drawing sliver compared with those of raw cotton in relation to yarn strength and yarn appearance,"** Washington, D. C., U. S. Dept. of Agriculture, Production and Marketing Administration, Cotton Branch, 1951, 80 pp.

F. Fabric Behavior

1289. Anderson, S. L., **Time effects in stressed fabrics: I: Relation between breaking load and breaking time in rubberized cotton fabrics,** *Selected Govt. Research Repts.* (London) (Textiles and Their Testing) **4**, 19–28 (1949) (*Chem. Abstracts* **46**, 5851b (1952)).

1290. Anderson, S. L., **Time effects in stressed fabrics: II: Application of the law relating breaking load and breaking time to fabrics under two-dimensional stress,** *Selected Govt. Research Repts.* (London) (Textiles and Their Testing) **4**, 29–34 (1949) (*Chem. Abstracts* **46**, 5851b (1952)).

1291. Anderson, S. L., **Time effects in stressed fabrics: III: Relation between breaking load and time under load for nylon,** *Selected Govt. Research Repts.* (London) (Textiles and Their Testing) **4**, 35–40 (1949) (*Chem. Abstracts* **46**, 5851c (1952)).

1292. Backer, S., **Cover factor adjustments for twill weaves,** TEXTILE RESEARCH JOURNAL **22**, 435–6 (1952) (Letter to the Editor).

1293. Benko, J. V., and Monfort, F., **Preliminary attempts at quantitative measurement of the regularity of fabric appearance,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 461–70 (in French).

1294. Bouvet, R., **Fiber-fabric relationships,** *Ind. Eng. Chem.* **44**, 2125–8 (1952).

1295. Bryant, F., **The softness and handle of textile fibres and fabrics,** *Text. J. Australia* **27**, 1130–1, 1135 (1952).

1296. Cox, H. L., **The elasticity and strength of paper and other fibrous materials,** *Brit. J. Applied Phys.* **3**, 72–9 (1952).

1297. Dorkin, C. M., and Chamberlain, N. H., **The causes of seaming damage and pinholing in cotton and rayon fabrics: I: Seaming damage,** *J. Text. Inst.* **43**, T203–33 (1952).

1298. Dorkin, C. M., and Chamberlain, N. H., **The causes of seaming damage and pinholing in cotton and rayon fabrics: II: Pinholing,** *J. Text. Inst.* **43**, T536–44 (1952).

1299. Fletcher, H. M., and Roberts, S. H., **The geometry of knit fabrics made of staple rayon and nylon and its relationship to shrinkage in laundering,** TEXTILE RESEARCH JOURNAL **22**, 466–71 (1952).

1300. Fletcher, H. M., and Roberts, S. H., **The geometry of plain and rib knit cotton fabrics and its relation to shrinkage in laundering,** TEXTILE RESEARCH JOURNAL **22**, 84–8 (1952).

1301. Frederick, E. B., **Development of a sewability test for cotton fabrics,** TEXTILE RESEARCH JOURNAL **22**, 687–92 (1952).

1302. Hoerner, S. F., **Aerodynamic properties of screens and fabrics,** TEXTILE RESEARCH JOURNAL **22**, 274–80 (1952).

1303. Hoffman, R. M., **Some theoretical aspects of yarn and fabric density,** TEXTILE RESEARCH JOURNAL **22**, 170–8 (1952).

1304. Jameson, L. H., Whittier, B. L., and Schiefer, H. F., **Factors affecting the properties of rayon fabrics,** TEXTILE RESEARCH JOURNAL **22**, 599–608 (1952).

1305. Mal'kova, D. G., and Kudinova, M. D., **Testing of fabrics for thread slippage,*** *Tekstil. Prom.* **12**, No. 7, 42 (1952) (*Faserforsch. u. Textiltech.* **3**, 463 (1952)).

1306. Meos, A. I., **The question of the feltability of textiles,*** *Tekstil. Prom.* **12**, No. 8, 26 (1952); *Textil-Praxis* **7**, 908–10 (1952).

1307. Mori, H., **Measurement of yarn density of fabrics with a lattice: IV: Uniform lattice inclination method,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 364–5 (1949) (*Chem. Abstracts* **46**, 4237g (1952)).

1308. Mori, H., **Measurement of yarn density of fabrics with a lattice: V: Curve patterns from the lattice plate set unevenly or evenly but on uneven cloth,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 199–202 (1951) (*Chem. Abstracts* **46**, 4237h (1952)).

1309. Morrison, B. V., Ward, R. L., Davison, S., and Macormac, A. R., **"Physical and chemical characteristics of suiting fabrics composed of wool, and wool combined with mohair, nylon, and rayon,"** Washington, D. C., U. S. Dept. of Agriculture, Agr. Res. Adm., Bur. Human Nutrition and Home Economics, No. 104, 1952, 20 pp.

1310. Painter, E. V., **Locating a fabric on the fabric geometry graph,** TEXTILE RESEARCH JOURNAL **22**, 556–7 (1952) (Letter to the Editor).

1311. Painter, E. V., **Mechanics of elastic performance of textile materials: VIII: Graphical analysis of fabric geometry,** TEXTILE RESEARCH JOURNAL **22**, 153–69 (1952).

1312. Press, J. J., **The character of wool-like fabrics: A basic study from an engineering viewpoint,** *J. Text. Inst.* **43**, P699–717 (1952).

1313. Schiefer, H. F., and Werntz, C. W., **The influence of fabric structure on abrasion resistance,*** *Textil-Praxis* **7**, 57–63 (1952).

See also [244, 1114–1129, 1244, 1571]

XI. MANUFACTURING

A. General

1. Raw Materials

(a) Protein Fibers

1314. Berezina, O. IA., **The wool of sheep of new breeds and breed-groups,*** *Tekstil. Prom.* **11**, No. 10, 10–12 (1951); *Faserforsch. u. Textiltech.* **3**, 115–17 (1952).

1315. Conant, R., **Anthrax in the wool textile industry,** *Can. Text. J.* **69**, No. 9, 63–4; No. 10, 67–8 (1952).

1316. Evans, T. F., Burte, H. M., and Wakelin, J. H., **Problems in the variability of wool encountered in worsted processing,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 129–34; *Can. Text. J.* **69**, No 21, 61–6 (1952).

1317. Haigh, H., **British wool grade names,** *J. Text. Inst.* **43**, P242–4 (1952).

1318. Haigh, H., and Newton, B. A., **"The wools of Britain,"** London, Sir Isaac Pitman, 1952, 78 pp. + 1 map and 44 plates (reviewed in *J. Text. Inst.* **43**, P768 (1952)).

1319. Kilborne, W. S., **Impact (of newer fibers) on established fibers: Silk,** *Ind. Eng. Chem.* **44**, 2166–8 (1952).

1320. Lund, L. O., Phelps, E. L., and Norton, H. W., **"Wearing quality of reused wool: A study of the physical characteristics of new and worn flannels containing new and reused wool,"** Bulletin 415, Brookings, S. D., Agricultural Experiment Station, 1951, 31 pp.

1321. Nitschke, G., **The production, properties, and combing of coarse Soviet wools: III,*** *Faserforsch. u. Textiltech.* **3**, 257–9 (1952).

1322. Nitschke, G., and Fehres, H., **The production, properties, and combing of coarse Soviet wools: II,*** *Faserforsch. u. Textiltech.* **3**, 5–18 (1952).

1323. Nitschke, G., and Schramm, S., **The production, properties, and combing of coarse Soviet wools: I,*** *Faserforsch. u. Textiltech.* **2**, 355–64 (1951).

1324. Norton, W. E., **Problems relating to the processing of sheepskins,** *Text. J. Australia* **27**, 343–7 (1952).

1325. Peryman, R. V., Henderson, A. E., and McMahon, P. R., **Significance of hairiness (medullation) to the wool textile industry: II: Corriedale hogget wools,** *New Zealand J. Sci. Technol.* **34A**, 47–58 (1952) (*J. Text. Inst.* **43**, A839 (1952)).

1326. Shaw, J. H., **British wools,** *J. Text. Inst.* **43**, P322–30 (1952).

1327. Thieme, G., **The recovery of pulled wool,*** *Melliand Textilber.* **33**, 1003–5 (1952).

1328. von Bergen, W., **Impact (of newer fibers) on established fibers: Wool,** *Ind. Eng. Chem.* **44**, 2157–63 (1952).

1329. Wadsworth, W. R., **The future of silk in the hosiery industry,** *J. Text. Inst.* **43**, P94–8 (1952).

(b) Cellulose Fibers

1330. Anon., **Base book of textile statistics,** *Textile Organon* **23** (Jan. 1952) (entire issue).

1331. Ashton, H., **Use of dyed viscose rayon staple fibre,** *Can. Text. J.* **69**, No. 15, 61–3 (1952).

1332. Cook, J. M., **1951 Cotton—how good? Six-year comparison favors new crop,** *Textile World* **102**, No. 2, 134–5 (1952).

1333. Defore, H., **1951 Cotton—how good? Mill tests show '51 cotton better than '48,** *Textile World* **102**, No. 2, 136–7 (1952).

1334. Fitzgerald, L. K., **Impact (of newer fibers) on established fibers: Cotton,** *Ind. Eng. Chem.* **44**, 2164–6 (1952).

1335. Goldberg, J. B., **Impact (of newer fibers) on established fibers: Viscose,** *Ind. Eng. Chem.* **44**, 2169–70 (1952).

1336. Mangum, G. D., Jr., and Buck, G. S., Jr., **Tar spot report: Exterior tar spot concentration ten times that inside bale,** *Textile Inds.* **116**, No. 3, 132–8 (1952).

1337. Meijberg, J. C., **A.K.U. rayon filament yarn spun continuously,** *Rayon Rev.* **5**, 9–15 (1951) (English edition).

1338. Oleman, V. E., **Effect of waste machine process on staple,** *Textile Bull.* **78**, No. 2, 68, 70 (1952).

MANUFACTURING

1339. Seiche, H., **The problem of tar spots,*** *Melliand Textilber.* **33**, 465–6 (1952).

1340. Tenney, A. M., **Impact (of newer fibers) on established fibers: Acetate,** *Ind. Eng. Chem.* **44**, 2171–5 (1952).

1341. Wishart, C. H., **Blazing a trail with carpet rayon fibre,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 87–9.

See also [1189]

(c) *Synthetic Fibers*

1342. Anon., **Annual synthetics section,** *Textile World* **102**, No. 9, 71–92 (1952).

1343. Bredée, H. L., **Synthetic fibrous materials: Developments and prospects,** *Rayon Rev.* (special Enkalon issue), 3–9 (1952) (English edition).

1344. Coke, C. E., **Properties and uses of the newer man-made fibres,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 94–9.

1345. Dillon, J. H., **Problems accompanying the introduction of the newer synthetic fibers,** *ASTM Bull.*, No. 184, 56–61 (1952); *De Tex* **11**, 650–4 (1952).

1346. Döhle, W., **A review of the synthetic fibers,*** *Textil-Praxis* **7**, 567–70 (1952).

1347. Gantz, G. M., **Textile fibers from synthetic textiles [resins?],** *Am. Dyestuff Reptr.* **41**, P100–4, P116 (1952).

1348. Grew, H. S., Jr., **Uses for the newer fibers: Industrial applications,** *Ind. Eng. Chem.* **44**, 2140–4 (1952).

1349. Hill, R., **Synthetic fibres in prospect and retrospect,** *J. Soc. Dyers and Colourists* **68**, 158–68 (1952).

1350. Koch, P. A., **Chemical fibers: A review of their variety and their properties,*** *Textil-Rundschau* **7**, 559–85 (1952).

1351. Lake, G. K., **Properties of fabrics made from several synthetic fibers and their impact on the textile industry,** TEXTILE RESEARCH JOURNAL **22**, 138–43 (1952).

1352. Lake, G. K., **Uses for the newer fibers: Domestic applications,** *Ind. Eng. Chem.* **44**, 2145–7 (1952).

1353. Mauersberger, H. R. (editor), **"American handbook of synthetic textiles,"** New York, Textile Book Publishers, Inc., 1952, 1216 pp. (reviewed in TEXTILE RESEARCH JOURNAL **22**, 763 (1952)).

1354. Mersereau, H. C., **Developments in new synthetic fibres,** *Can. Text. J.* **69**, No. 7, 57–9 (1952).

1355. Pieper, E., **The synthetic fibers: Something of their properties, manufacture and use,*** *Textil-Praxis* **7**, 608–16 (1952).

1356. Quig, J. B., and Dennison, R. W., **Functional properties of synthetics,** *Ind. Eng. Chem.* **44**, 2176–83 (1952).

1357. Rainard, L. W., **Continuous filament crimping,** *Textile Bull.* **78**, No. 12, 70, 72–3 (1952).

1358. Ray, L. G., Jr., **The role of synthetic fibers in the textile industry of the future,** TEXTILE RESEARCH JOURNAL **22**, 144–51 (1952).

1359. Saxl, V., **How should long-staple synthetics be processed?** *Textile World* **102**, No. 1, 131, 133, 237–8, 240, 242 (1952).

1360. Smith, R. A., **Handling the newer synthetics on the woolen system,** *Textile World* **102**, No. 1, 100–3, 246, 248 (1952).

1361. Spiro, A. M., **Uses for the newer fibers: Woven apparel fabrics,** *Ind. Eng. Chem.* **44**, 2151–3 (1952).

1362. Traill, D., **The problem of the synthetic fiber,*** *Bull. inst. text. France*, No. 30, 109–30 (1952).

1363. Whytlaw, G. G., **The processing of Acrilan acrylic fiber,** *Papers AATT* **8**, 16–18 (1952).

1364. Zeller, F., **Synthetic fibers in the weaving mill,*** *Textil-Praxis* **7**, 600–5 (1952).

See also [670]

2. *Operation of Mills and Machinery*

1365. Bierlin, W. E., **Lubrication of high-speed textile machines,** *Rayon and Synthetic Texts.* **33**, No. 7, 79–81 (1952).

1366. Bogren, G. G., **Treatment of cotton-finishing waste at Sayles Finishing Plants, Inc.,** *Sewage and Ind. Wastes* **24**, 994–1000 (1952) (*Chem. Abstracts* **46**, 9316d (1952)).

1367. Carter, E. G., **Recent advances in the processing of wool,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 165–73 (in English).

1368. Crump, J. P., **Factors in plant development: A weaving industrialist's point of view,** *J. Text. Inst.* **43**, P836–44 (1952).

1369. Davison, E. H., **Factors in plant development: An accountant's point of view,** *J. Text. Inst.* **53**, P868–79 (1952).

1370. Dougherty, J. E., Dance, L. H., and Martin, W. H., **The relation of mill processing conditions to yarn and fabric properties,** *Textile Inds.* **116**, No. 10, 111–26 (1952).

1371. Garrett, D. A., **A broken-filament detector,** *Hexagon Digest*, No. 12, 22–5 (1952).

1372. Greg, H. G., **Factors in plant development: A spinning industrialist's point of view,** *J. Text. Inst.* **43**, P829–35 (1952).

1373. Higgins, S. P., Jr., and McKnight, G. W., **Practical application of servomechanism techniques to a process-control problem,** TEXTILE RESEARCH JOURNAL **22**, 203–13 (1952).

1374. Hill, D. W., **Factors in plant development: A research point of view,** *J. Text. Inst.* **43**, P855–67 (1952).

1375. Honegger, E., and Osterwalder, K., **Light metals in the textile industry,*** *Textil-Rundschau* **7**, 51–64 (1952).

1376. Kirkish, J. J., and Weitekamp, M., **Matching electric motors to textile machinery,** *Textile Age* **16**, No. 12, 50–5 (1952).

1377. Meyer, W., **Fiber technology and textile machinery construction with special reference to modern measurement technique,*** *Reyon Zellwolle u. Chemiefasern* **30**, 326–8 (1952).

1378. Mezener, M., **Radioactivity and worker protection * (with comment from "Teletron," and further comment by the author),** *Textil-Rundschau* **7**, 188–93, 419–22 (1952).

1379. Newell, W. A., **This principle and this machine [electronic calculator] help Hathaway control efficiency and quality,** *Textile World* **102**, No. 7, 87–91 (1952).

1380. Palm, C., and Buch, K. R., **On the distribution of the labor attending automatic machines,*** *Tids. Textilteknik* **10**, 93–104 (1952).

1381. Preysch, F., **Modern textile machinery in Swiss spinning mills,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 22–6 + 4 plates.

1382. Rudnick, E. S., **Wamsutta's new waste control program,** *Textile Inds.* **116**, No. 7, 68–82 (1952).
1383. Russell, R. M. L., **Handling of solvents in textile mills,** *Can. Text. J.* **69**, No. 11, 63–4, 67 (1952).
1384. Salquain, J., **Nuclear energy and the textile industry,*** *Teintex* **17**, 771, 773–4, 777, 779–80, 783, 785–6 (1952).
1385. Sears, W. B., **Organized quality control as an aid to mill men,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 76–83.
1386. Stott, K. A., **Factors in plant development: A finishing industrialist's point of view,** *J. Text. Inst.* **43**, P845–54 (1952).
1387. Truslow, N., **U. S. Rubber's novel sample method,** *Textile Inds.* **116**, No. 5, 90–2 (1952).
1388. von Bergen, W., and Wakelin, J. H., **Properties of apparel wools: I: Preliminary report on worsted processing trials,** TEXTILE RESEARCH JOURNAL **22**, 123–37 (1952).
1389. Walter, L., **Controlled humidification in textile plants,** *Textile Bull.* **78**, No. 7, 88–90 (1952).
1390. Webster, A., **Quality control in textile production,** *Textile Manufacturer* **78**, 333–6 (1952).
1391. Williams, D. R. H., **"Machinery, management and control in a wool textile factory,"** 2nd ed., Manchester, Emmott and Co., Ltd., 1952, 257 pp. (reviewed in *Melliand Textilber.* **34**, 86 (1953)).

See also [1001]

3. *Processing of Blends*

1392. Alibert, I. M., **The use of vinyl filaments and vinyl fibers in mixtures with filament rayon and rayon staple,*** *Reyon Zellwolle u. Chemiefasern* **30**, 5–8 (1952).
1393. Ashton, H., **Recent developments in the spinning of rayon staple, particularly rayon-cotton blends,*** *Rayonne et fibres synthét.* **8**, No. 1, 51–6 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 9–13 (1952).
1394. Barr, T., and Haigh, D., **Wool/protein-fibre blends in felt manufacture,** *J. Text. Inst.* **43**, P593–603 (1952).
1395. Brandt, C. D., **Spinning worsteds and blends on the American system,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 90–3.
1396. Brown, H. F., **An introduction to the preparation and properties of yarns containing Ardil protein fibre,** *J. Text. Inst.* **43**, P584–92 (1952).
1397. Corry, W. A., **Studies of summer weight tropical worsted fabrics made with polyester fibers and blends of polyester fibers,** *J. Text. Inst.* **43**, P670–80 (1952).
1398. Crone, H. R., **Fibre blends as carpet surface yarns,** *J. Text. Inst.* **43**, P533–55 (1952).
1399. Dennison, R. W., and Leach, L. L., **Blends containing the new man-made fibres,** *J. Text. Inst.* **43**, P473–95 (1952).
1400. Gale, P. T., and Sagar, H., **The value of processing aids in the handling of fibres and fibre blends,** *J. Text. Inst.* **43**, P496–510 (1952).
1401. Giraudi, G., **Factors in blending and spinning man-made and synthetic fibers with each other and with wool,*** *Rayonne et fibres synthét.* **8**, No. 5, 7, 9–15, 17–18 (1952).
1402. Greenwood, R. S., **Blends incorporating viscose rayon staple,** *J. Text. Inst.* **43**, P511–18 (1952).
1403. Hall, W. J., **Mixture fabrics for cartridge bags,** *J. Text. Inst.* **43**, P661–9 (1952).
1404. Hardacre, W., **The scope of blends of man-made and natural fibres in the knitting industry,** *J. Text. Inst.* **43**, P80–7 (1952).
1405. Howden, C., **Examination of methods of blending viscose rayon staple fibre with wool on worsted machinery,** *J. Text. Inst.* **43**, P401–12 (1952).
1406. Howden, C., **Wool-viscose blends for combed "Open drawing,"** * *Rayonne et fibres synthét.* **8**, No. 6, 17–21, 23–5 (1952).
1407. Hunter, W. A., **Fibre blending,** *J. Text. Inst.* **43**, P365–74 (1952).
1408. Ingham, J. S., **Some consumers' observations on fabrics and garments made from blended yarns,** *J. Text. Inst.* **43**, P612–25 (1952).
1409. Kennedy, S. J., **Fiber blends in military textiles,** *J. Text. Inst.* **43**, P681–98 (1952).
1410. Lund, G. V., **The blending of viscose rayon and other fibres with particular reference to the cotton system of processing,** *J. Text. Inst.* **43**, P375–90 (1952).
1411. Lund, G. V., and Sneyd, H., **Processing of rayon-wool blends on cotton spinning machinery,*** *Rayonne et fibres synthét.* **8**, No. 11, 9–11 (1952).
1412. McGill, A., and Wild, H., **Blends of acetate staple and other fibres,** *J. Text. Inst.* **43**, P451–65 (1952); *Rayonne et fibres synthét.* **9**, No. 1, 49–64 (1953); *Reyon Zellwolle u. Chemiefasern* **31**, 17–25 (1953).
1413. Millard, F., and Thornton, P., **Production and properties of yarns containing nylon staple mixed with cotton, rayon and wool,** *J. Text. Inst.* **43**, P413–50 (1952).
1414. Mouchiroud, G., **The blending of polyvinyl chloride fibres with other fibres,** *J. Text. Inst.* **43**, P466–72 (1952).
1415. Nuding, H., **Fibre blends: The influence of the properties of fibres,** *J. Text. Inst.* **43**, P352–64b (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 478–86 (1952).
1416. Robinson, G., **Wool and other fibres as components of carpet pile yarns,** *J. Text. Inst.* **43**, P519–32 (1952).
1417. Schmauder, K., **Spinning Perlon alone and in mixtures,*** *Textil- u. Faserstofftech.* **2**, 271–4 (1952) (*Faserforsch. u. Textiltech.* **3**, 512 (1952)).
1418. Thornton, P., and Townend, P. P., **Wool and nylon staple blends on the Bradford open drawing worsted system: Processing aspects and yarn properties,** *J. Text. Inst.* **43**, T268–77 (1952).
1419. Viviani, E., **Physical properties of continuous filament and spun yarns of the same material, with respect to their use in the textile industry and their rational utilization in blends,*** *Rayonne et fibres synthét.* **8**, No. 11, 15, 17, 19, 21, 23, 25, 27–30 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 584–91 (1952).
1420. Waggett, G., **The relationship between blend composition and some processing properties of rayon staple on cotton spinning machinery,** *J. Text. Inst.* **43**, P391–400 (1952).
1421. Wegener, W., **Fluctuations in the blending ratio of union yarns,*** *Melliand Textilber.* **33**, 450–3 (1952).
1422. Whytlaw, G. G., **The manufacture of fabrics from blends of fibers,** *J. Text. Inst.* **43**, P556–83 (1952).
1423. Wilhelm, A., **Experiments on mixed yarn,*** *Textil-Praxis* **7**, 590–3 (1952).

See also [1526, 1887, 1889]

MANUFACTURING

4. Static Electricity

1424. Aigrain, M., **The battle against static electricity in spinning,*** *Industrie textile* **69**, 26–8 (1952) (*J. Text. Inst.* **43**, A505 (1952)).

1425. Bertolina, G., **Elimination of static electricity from acetate rayon,*** *Rayonne et fibres synthét.* **7**, No. 4, 41–4 (1951).

1426. Edelstein, S. M., **Static electricity in textiles,** *Am. Dyestuff Reptr.* **41**, P518–24 (1952).

1427. Graham, G. W., **Some research on the generation and inhibition of static electricity,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 32–5.

1428. Hall, A. J., **Fibre electrification and anti-static treatments: Measuring static on fabric,** *Text. Mercury & Argus* **126**, 1103, 1105 (1952) (*J. Text. Inst.* **43**, A741 (1952)).

1429. Hall, A. J., **Fibre electrification and anti-static treatments: Measuring static on loose fibres,** *Text. Mercury & Argus* **126**, 1009, 1011, 1013 (1952) (*J. Text. Inst.* **43**, A740 (1952)).

1430. Hall, A. J., **Fibre electrification and anti-static treatments: Some methods of prevention,** *Text. Mercury & Argus* **127**, 152, 155, 157 (1952) (*J. Text. Inst.* **43**, A805 (1952)).

1431. Hearle, J. W. S., **The electrical resistance of textile materials: A review of the literature,** *J. Text. Inst.* **43**, P194–223 (1952).

1432. Hersh, S. P., and Montgomery, D. J., **Electrical resistance measurements on fibers and fiber assemblies,** TEXTILE RESEARCH JOURNAL **22**, 805–18 (1952).

1433. Krüger, K., **The elimination of static electricity in the processing of synthetic fibers of all types,*** *Reyon Zellwolle u. Chemiefasern* **30**, 573–7 (1952).

1434. Lopez, J. A., and Hewson, J. K., **Static problems and their control in the textile industry,** *Am. Dyestuff Reptr.* **41**, P105–9 (1952).

1435. Schneider, J., **The removal of electrostatic charge by static eliminators: The Ionotron,*** *SVF Fachorgan Textilveredl.* **6**, 303–9 (1951) (*J. Text. Inst.* **43**, A234 (1952)).

See also [1042, 1378, 1400]

B. Preliminary Processes

1. Opening and Blending

1436. Frolova, T. A., **The influence of the beater speed on the degree of opening of cotton,*** *Tekstil. Prom.* **12**, No. 8, 8–9 (1952) (*Faserforsch. u. Textiltech.* **3**, 511 (1952)).

1437. Grant, P. C., **Modern cotton mill preparatory machinery,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 18–21.

1438. Mersereau, E. P., **Wool-blending costs cut 10% with spectrophotometer,** *Textile World* **102**, No. 3, 155, 157 (1952).

1439. Regnery, W., **Blending of cotton by fineness determination and other applications of research in mill operation,** TEXTILE RESEARCH JOURNAL **22**, 49–52 (1952).

1440. Shelton, C. L., **We check our wool blending with ultraviolet light,** *Textile World* **102**, No. 1, 108–9 (1952).

See also [1401, 1405, 1407]

2. Wool Scouring

1441. Anon., **Cockling and blistering,** *Dyer* **107**, 557–8 (1952).

1442. Anon., **The scientist looks at the wool industry: Scouring: II: Wools which are difficult to scour,** *Wool Science Rev.*, No. 9, 30–43 (1952).

1443. Anon., **Scouring,** *Wool Science Rev.* No. 8, 3–23 (1952).

1444. Bhat, G. N., **Studies on the scouring temperature of wool wax,** *Indian Text. J.* **62**, 750–2 (1952).

1445. Chauvet, A., **Wool scouring,*** *Industrie textile* **67**, 418–20 (1950) (*Chem. Abstracts* **46**, 4238i (1952)).

1446. Frenzel, W., and Wolf, S., **The scouring of wool by freezing,*** *Faserforsch. u. Textiltech.* **3**, 184–9 (1952).

1447. Garlinskaia, E. I., Dolgopolov, N. N., Matetskii, A. I., and Ruban, E. L., **The scouring of wool by means of ultrasonics,*** *Tekstil. Prom.* **12**, No. 4, 10 (1952) (*J. Text. Inst.* **43**, A642 (1952)).

1448. Higgins, E. B., **A miniature yarn scouring apparatus,** *Hexagon Digest*, No. 11, 25–30 (1952).

1449. Jordan, T. E., Volz, G., Gelb, J., and Romanovsky, C., **The effects of magnesium ions on the detergency of wool using sodium dodecyltoluenesulfonate,** *Am. Dyestuff Reptr.* **41**, 413–14 (1952).

1450. Lister, G. H., **Factors influencing the efficiency of wool scouring and its importance to the dyer,** *Textile Recorder* **69**, No. 826, 91–2 (1952).

1451. Lister, G. H., **Factors influencing the efficiency of wool scouring and its importance to the dyer: The scouring of wool,** *Textile Recorder* **69**, No. 828, 83–4 (1952).

1452. Lister, G. H., **Factors influencing the efficiency of wool scouring and its importance to the dyer: Substantivity of detergents,** *Textile Recorder* **69**, No. 827, 83–4 (1952).

1453. Mansfield, W. W., **Detergency: II: The removal of oil from wool fibres,** *Australian J. Applied Sci.* **3**, 193–200 (1952).

1454. Singer, J. J., and Bersworth, F. C., **Organic complexing agents in textile processing,** *Am. Dyestuff Reptr.* **41**, P365–70 (1952).

See also [991, 992, 996, 1151, 1154, 1885]

3. Lubrication

1455. Audley, R. S., **Oiling in worsted and woollen yarn manufacture,** *Textile Inds. and Fibres* **12**, 403–5 (1951).

1456. Dadachanji, C. J., **Glycol fatty acid esters in textile processing,** *Indian Text. J.* **63**, 100–4 (1952).

1457. Démarcq, M., **New results on the oxidation of oils used in finishing,*** *Teintex* **17**, 541–2, 545, 547–8 (1952).

1458. Gire, C., **Use of nonionic emulsifiers in the lubrication of jute,*** *Industrie textile* **68**, 117–22 (1951) (*Chem. Abstracts* **46**, 4802a (1952)).

1459. Günther, A. K., **The oiling of rayon staple fiber for combing and worsted spinning,*** *Textil-Praxis* **6**, 855–8 (1951).

1460. Hirsbrunner, H. R., **The washing out of textile oils containing mineral oils and influence of the latter on the dyeing process,*** *Bull. mens. ITERG* (Inst. tech. études et recherches corps gras) **5**, 355–65, 414–34 (1951) (*Chem. Abstracts* **46**, 1261f (1952)).

1461. Kehren, M., **Iron-containing oleins,*** *Melliand Textilber.* **33**, 853–5 (1952).

1462. Martin, P. J., **The engineering approach to woolen-fiber lubrication,** *Am. Dyestuff Reptr.* **41**, P341–4 (1952).

1463. Parisot, A., **General observations on the oiling of textile fibers,*** *Bull. inst. text. France*, No. 30, 387–404 (1952).

1464. Ryberg, B. A., **Important characteristics of wool oil,** *Am. Dyestuff Reptr.* **41**, 189–92, 213 (1952).

1465. Serebriakov, A. M., **Ethylene glycol emulsion for lubrication of wool,*** *Tekstil. Prom.* **10**, No. 11, 25–7 (1950) (*Chem. Abstracts* **46**, 6393c (1952)).

1466. Sørensen, T., **Spinning oils,*** *Tids. Textilteknik* **10**, 50–6 (1952).

See also [1708]

C. Carding

1467. Anon. **Burr removal in woollen carding,** *Wool Science Rev.*, No. 8, 24–32 (1952).

1468. Anon., **The scientist looks at the wool industry: I: Carding,** *Wool Science Rev.*, No. 9, 3–14 (1952).

1469. Bogdan, J. F., and Feng, I. Y. T., **Neps and how to control them,** *Textile World* **102**, No. 5, 91–106 (1952).

1470. Grover, E. B., **How to control neps,** *Textile Age* **16**, No. 4, 46–9 (1952); *Textile World* **102**, No. 2, 138, 270, 272 (1952).

1471. Klock, A. G., and Carter, C. W., **Variable-speed intermediate feed improves card roving,** *Textile World* **102**, No. 7, 105–7 (1952).

1472. Newnam, J. A., **How to do a better job in carding 3-den. nylon,** *Textile World* **102**, No. 12, 114–15, 194, 196 (1952).

1473. Rakov, A. P., **The importance of the front knives on the card,*** *Tekstil. Prom.* **12**, No. 5, 18–21 (1952); *Faserforsch. u. Textiltech.* **3**, 329–33 (1952).

1474. Roig-Serra, L., **Benefits obtained by control of atmospheric conditions during carding,*** *Bull. inst. text. France*, No. 30, 365–70 + 2 pp. figures (1952).

1475. Rouse, J. T., and Burley, S. T., Jr., **"Performance of selected commercial varieties of cotton when processed at varying rates of card production,"** Washington, D. C., U. S. Dept. of Agriculture, Production and Marketing Administration, Cotton Branch, Mar. 1952, 56 pp.

1476. Thomas, P. M., **What happens when you speed up cotton cards?** *Textile World* **102**, No. 10, 94–7 (1952).

1477. Thorndike, G. H., **Efficiency of a comb on a wool card,*** *Bull. inst. text. France*, No. 30, 195–211 (1952).

1478. Townend, P. P., **Major problems in woollen carding,** *Textile Recorder* **70**, No. 831, 91–3 (1952).

1479. Voroshilov, V. A., **The carding process in the flat and roller card,*** *Tekstil. Prom.* **11**, No. 11, 16–20 (1951); *Textil-Praxis* **7**, 680–4 (1952).

1480. Waggett, G., **Some quantitative characteristics of the loading of cotton card cylinders,** *J. Text. Inst.* **43**, T433–42 (1952).

1481. Webb, R. W., and Richardson, H. B., **"Neps in card web as related to six elements of raw cotton quality,"** Washington, D. C., U. S. Dept. of Agriculture, Production and Marketing Administration, Cotton Branch, May 1951, 54 pp.

1482. Webb, R. W., and Richardson, H. B., **"Relation of rate of carding and factors of cotton quality to strength and appearance of carded yarn, neps in card web, and percentage of card waste,"** Washington, D. C., U. S. Dept. of Agriculture, Production and Marketing Administration, Cotton Branch, June 1952, 44 pp.

D. Drafting and Spinning

1. Drafting

1483. Audley, R. S., **The roving process in worsted drawing,** *Textile Inds. and Fibres* **13**, 85–8 (1952).

1484. Corley, J. R., and Simpson, J., **Draft proportionment for coarse, short-staple cotton on long-draft roving systems,** *Textile Inds.* **116**, No. 12, 125–9, 131 (1952).

1485. Dakin, G., Foster, G. A. R., and Locke, J., **Irregularities in cotton and rayon-staple slivers caused by roller slip at the drawframe,** *J. Text. Inst.* **43**, T545–62 (1952); *Shirley Inst. Mem.* **26**, 23–40 (1952).

1486. Green, J., and Ingham, J., **A technique for visualising the position of staple fibres in a sliver, and its application to drafting problems,** *J. Text. Inst.* **43**, T473–88 (1952).

1487. Hadwich, F., **The twist-draft system as a further development of the twist-tube and its effect on spinning, weaving and finishing,*** *Textil-Praxis* **7**, 113–19, 189–92 (1952).

1488. Hannah, M., **Contact stress and deformation in a thin elastic layer (drafting rollers),** *Quart. J. Mech. Appl. Math.* **4**, 54–105 (1951) (*J. Text. Inst.* **43**, A711 (1952)).

1489. Ivanov, S. S., **The present state of the theory and practice of drawing,*** *Tekstil. Prom.* **12**, No. 4, 13–16 (1952) (*Faserforsch. u. Textiltech.* **3**, 339 (1952)).

1490. Longstreet, J. R., **Integration of converter and pin drafter to worsted system,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 135–8.

1491. Pilz, G., **Fluting of drawing rollers,*** *Melliand Textilber.* **33**, 839–40 (1952).

1492. Power, B. K., and Towery, J. D., **Roving draft calculations by nomograph,** *Textile Inds.* **116**, No. 1, 134–5 (1952).

1493. Reinfeld, N., **Movement and guiding of fibers in the main component unit of a drawing frame for cotton and rayon staple,*** *Melliand Textilber.* **33**, 493–6 (1952).

See also [1217–1240, 1400, 1410, 1418]

2. Spinning

1494. Angus, J., and Martindale, J. G., **An instrument for measuring the forces developed during mule spinning,** *J. Text. Inst.* **43**, T565–78 (1952).

1495. Anon., **The Saco-Lowell Gwaltney spinning frame,** *Can. Text. J.* **69**, No. 8, 71–2, 75 (1952).

1496. Bassett, W. E., **Spinning properties of acetate staple,** *Can. Text. J.* **69**, No. 10, 59–62 (1952).

1497. Blümcke, A., **Wet spinning of flax yarns at low spinning bath temperatures,*** *Textil-Praxis* **7**, 882–5 (1952).

1498. Burger, G., **The quality of spinning,*** *Textil-Praxis* **7**, 416–22 (1952).

1499. Farnsworth, H. V., **The Bradford system of spinning and drawing,** *Papers AATT* **7**, 164–7 (1952).

MANUFACTURING

1500. Frenzel, W., **Flax spinning,*** *Faserforsch. u. Textiltech.* **3**, 214–22 (1952).

1501. Frenzel, W., and Bettermann, K., **The shortening of fiber processing in the cotton spinning mill,*** *Faserforsch. u. Textiltech.* **3**, 270–84 (1952).

1502. Frenzel, W., and Höhne, G., **Manufacture of low twist and fine cotton yarns by the pot-spinning process,*** *Faserforsch. u. Textiltech.* **3**, 295–300 (1952).

1503. Frenzel, W., and Liebscher, U., **The production of wet-spun flax in the spinning centrifuge,*** *Faserforsch. u. Textiltech.* **3**, 356–73, 390–400 (1952).

1504. Frenzel, W., and Luxa, M., **Spinning with a suppressed yarn balloon,*** *Faserforsch. u. Textiltech.* **3**, 483–9 (1952).

1505. Gerstel, J., **Fancy yarns and their application in a rayon mill,** *Text. J. Australia* **26**, 1126, 1128–30 (1952).

1506. Giraudi, G., **Latest trends in spinning long staple synthetic fibers,** *Textile Age* **16**, No. 12, 6–10, 13–15 (1952).

1507. Haas, H., **Principles underlying the steaming of textile materials and the advantages of carrying out this process in a vacuum,*** *Melliand Textilber.* **33**, 541–4 (1952).

1508. Haller, R., **Action of various vapors on spinning fibers,*** *Textil-Rundschau* **7**, 359–65 (1952).

1509. Hannah, M., **Applications of a theory of the spinning balloon: I,** *J. Text. Inst.* **43**, T519–35 (1952).

1510. Heller, G., **Dark and stained threads in linen fabrics,*** *Melliand Textilber.* **33**, 204–6 (1952).

1511. Johannsen, O., **The problem of the production rate on the ring spinning frame,*** *Textil-Praxis* **7**, 847–51, 934–8 (1952).

1512. Keverling-Buisman, J. A., **End breakage in ring spinning of viscose staple,*** *Rayonne et fibres synthét.* **8**, No. 4, 11, 13–23 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 381–7 (1952).

1513. Kittel, H., **Manipulations in woolen yarn spinning,*** *Melliand Textilber.* **33**, 601–2 (1952).

1514. Kittel, H., **"Worsted yarn spinning,"*** Wuppertal-Barmen, Spohr Verlag, 1951, 172 pp. (*J. Text. Inst.* **43**, A231 (1952)).

1515. Lund, G. V., **A comparative study of the regularity of rayon staple yarns spun on different spinning systems,** *J. Text. Inst.* **43**, T299–324 (1952).

1516. Lund, G. V., and Sneyd, H., **Spinning synthetic fibers on the woolen system,*** *Reyon Zellwolle u. Chemiefasern* **30**, 650–3 (1952); *Rayonne et fibres synthét.* **8**, No. 12, 11, 13, 15–19 (1952).

1517. Mangum, G. D., Jr., **Cotton fly,** *Textile Inds.* **116**, No. 12, 92–7 (1952).

1518. McConnell, R. J., **The American system of yarn production,** *Papers AATT* **7**, 161–3 (1952).

1519. National Cotton Council of America (Industry-Wide Committee on Cotton Quality), **"Cotton fiber properties, spinning efficiency and fabric quality as affected by ginning practices,"** Memphis, National Cotton Council of America, 1952, 40 pp.

1520. Oehlmann, E., **Burr crushing rollers in woolen spinning,*** *Melliand Textilber.* **33**, 1092–3 (1952).

1521. Oertel, F., **Yarn balloon separating rings for ring spindles,*** *Melliand Textilber.* **33**, 598–601 (1952).

1522. Osborne, J., **Long staple fibers—a developing trend,** *Textile Age* **16**, No. 3, 18–24 (1952).

1523. Parnev, V. A., **A high draft spinning machine,*** *Tekstil. Prom.* **12**, No. 8, 13–15 (1952) (*Faserforsch. u. Textiltech.* **3**, 512 (1952)).

1524. Quaas, K., **Simplified processes for spinning staple rayon,*** *Textil-Praxis* **7**, 578–9 (1952).

1525. Rudolph, L., **Spinning trials with rayon staple fiber of various staple lengths and titer: Preliminary experiments,*** *Faserforsch. u. Textiltech.* **3**, 169–81 (1952).

1526. Saxl, V., **An evaluation of the French spinning system for the spinning of wools, blends, and synthetic fibers,** *Papers AATT* **7**, 168–75 (1952).

1527. Schonhardt, O., **Spinning from the drawing frame in the cotton mill,*** *Melliand Textilber.* **33**, 117–18, 191–3 (1952).

1528. von Sengbusch, A., **Rope yarn spinning,*** *Melliand Textilber.* **33**, 409–10 (1952).

1529. Shepherd, W., and Chase, G. A., **Drafting flax fibre: Effects of direction of feed,** *Textile Manufacturer* **78**, 337–8 (1952).

1530. Smith, E., **Syton in the textile industry,** *Textile Manufacturer* **78**, 69–72 (1952).

1531. Tankus, L. IV., and Makarov, V. K., **Apparatus for measuring the frictional moment of a traveler on a ring,*** *Tekstil. Prom.* **12**, No. 8, 20 (1952) (*Faserforsch. u. Textiltech.* **3**, 512 (1952)).

1532. Thieme, G., **The chemical and mechanical preparation of flax fibers and their spinning, especially in woolen and semi-worsted processing,*** *Melliand Textilber.* **33**, 19–20 (1952).

1533. Tobisch, F., **Yarn breakage in worsted ring-spinning,*** *Textil-Praxis* **7**, 24–7, 107–13 (1952).

See also [1217–1313, 1393, 1395, 1400, 1401, 1411, 1417, 1418, 1420]

3. *Winding and Twisting*

1534. Emmerich, F., **Calculation and use of standard measures of efficiency in doubling and twisting,*** *Melliand Textilber.* **33**, 193–6 (1952).

1535. Knothe, B., **The twisting of Perlon,*** *Textil- u. Faserstofftech.* **2**, 274–6 (1952) (*Faserforsch. u. Textiltech.* **3**, 512 (1952)).

1536. Komarov, A. V., and Ginesin, G. I., **Effect of a thread balloon on thread jumping off the spool in the process of unwinding,*** *Tekstil. Prom.* **12**, No. 7, 24–5 (1952) (*Faserforsch. u. Textiltech.* **3**, 464 (1952)).

1537. Marsden, H., **Modern winding methods and machines,** *Textile Manufacturer* **78**, 77–83 (1952).

E. Weaving

1. *Warp Sizing*

1538. Abrams, E., **Warp-shed tester evaluates slasher size,** *Textile World* **102**, No. 2, 132–3, 286, 290 (1952).

1539. Anderson, G. M., **Problems in slashing synthetic fiber yarns,** *Textile Bull.* **78**, No. 5, 73–4, 76, 78 (1952).

1540. Anon., **The Shirley automatic size regulator,** *Skinner's Silk and Rayon Record* **26**, 462–3 (1952).

1541. Barnabe, N., **Preparation of spun rayon warps for weaving,*** *Rayonne et fibres synthét.* **8**, No. 6, 27–31, 33, 35; No. 7, 15, 17, 19–21, 23, 25 (1952).

1542. Huisinga, A. H., **Sizing rayon yarn,*** *De Tex* **11**, 236–7 (1952) (*Text. Tech. Digest.* **9**, 1112 (1952)).

1543. King, D. E., Weil, H. A., Condo, F. E., and Rutherford, H. A., **The evaluation of textile sizes,** TEXTILE RESEARCH JOURNAL **22**, 567–73 (1952).

1544. Langston, J. H., **Sizing of spun nylon yarns with various agents,** TEXTILE RESEARCH JOURNAL **22**, 111–16 (1952).

1545. Martin, M., **Sizing of rayon warps,*** *Bull. inst. text. France*, No. 33, 33–8 + 3 plates (1952).

1546. Naert, J., **Quality control in sizing,*** *Rayonne et fibres synthét.* **8**, No. 11, 37, 39, 41, 43, 45–6 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 603–7 (1952).

1547. Nakagawa, S., and Kawashima, H., **Properties of polyvinyl alcohol as warp-size,*** *Repts. Osaka Pref. Ind. Research Inst.* **4**, No. 1, 37–8 (1952) (*Chem. Abstracts* **46**, 11693f (1952)).

1548. Olsen, H. C., **Some thoughts on warp sizing,** *Textile Bull.* **78**, No. 12, 75–9 (1952).

1549. Parriaud, L., and Chabert, J., **Laboratory sizer,*** *Bull. inst. text. France*, No. 36, 27–31 + 2 plates (1952).

1550. Pinte, J., Essertel, Mlle., and Rochas, P., **Sizing of rayons in linseed oil solution,*** *Bull. inst. text. France*, No. 34, 15–51; No. 35, 25–49 (1952).

1551. Takahashi, T., and Miyake, S., **Industrial application of sodium alginate paste: II: Stiffness of sized cloths,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 442–5 (1951) (*Chem. Abstracts* **46**, 4239g (1952)).

1552. Takahashi, T., Obana, K., and Miyake, S., **Industrial application of sodium alginate paste: I: Frictional durability of sized warp threads,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 439–42 (1951) (*Chem. Abstracts* **46**, 4239f (1952)).

1553. Worth, D. L., **Abrasion test for sized yarns,** *Textile Inds.* **116**, No. 6, 92–5 (1952).

1554. van Zelst, E. F. Z., **Sizing cellulose yarns with salts of carboxy methyl cellulose,** *Indian Text. J.* **62**, 369–71, 360 (1952).

2. *Advances in Loom Construction*

1555. Anon., **Big felt loom features new electronic controls,** *Textile Age* **16**, No. 8, 6–10 (1952).

1556. Boigs, G., **New methods of loom construction,*** *Melliand Textilber.* **33**, 503–5 (1952).

1557. Focke, H., **A new circular loom,*** *Melliand Textilber.* **33**, 925–6 (1952).

1558. Gardner, E. R., **A critical examination of the Warner & Swasey Sulzer weaving machine,** *Textile Age* **16**, No. 7, 68–70 (1952).

1559. Gasser, A., **Automatic shuttle changing or bobbin changing device in the rayon weaving industry,*** *Melliand Textilber.* **33**, 840–1 (1952).

1560. Hesse, E. O., **The effect of the dividing rods in shedding,*** *Melliand Textilber.* **33**, 607–9 (1952).

1561. Hünlich, R., **A new shuttleless smallwares loom,*** *Melliand Textilber.* **33**, 200–2 (1952).

1562. Kaemmerer, W., **From loom to weaving machine,*** *Melliand Textilber.* **33**, 413–15 (1952).

1563. Mayer, M., Jr., Kyame, G. J., and Brown, J. J., **Improve your fabrics with the SRRL loom attachment,** *Textile World* **102**, No. 7, 114–15 (1952).

1564. Porter, I. S., **Modern loom design and improvement,** *Textile Inds. and Fibres* **12**, 408–11 (1951).

1565. Rossmann, R., **The way to a weaving machine without weft bobbins,*** *Textil-Praxis* **6**, 875–81 (1951).

1566. Schmiedel, E. W., **Ruti looms and preparatory equipment,** *Can. Text. J.* **69**, No. 1, 52–4, 57 (1952).

1567. Swales, J. N., **A method of designing shedding tappets,** *J. Text. Inst.* **43**, P143–52 (1952).

1568. Utecht, A., and Dehler, K.-H., **Economics of the automatic loom,*** *Melliand Textilber.* **33**, 501–2 (1952).

3. *Studies of Loom Operation*

1569. Alekseev, K. G., **The deformation of warp yarn during repeated stretching,*** *Faserforsch. u. Textiltech.* **3**, 284–9 (1952).

1570. Dyer, R. F., Faw, W. G., and Beard, R. L., **Some of the factors influencing yarn tension in warping,** TEXTILE RESEARCH JOURNAL **22**, 487–98 (1952).

1571. Foster, R., **Weaving investigations: Periodic patterning in fabrics,** *J. Text. Inst.* **43**, P742–54 (1952).

1572. Griese, H., **Warp tension control in weaving,*** *Textil-Praxis* **7**, 438–40 (1952).

1573. Heijnis, J. W. I., and Gonsalves, V. E., **Mechanical tension meters,** *Rayon Rev.* **5**, 24–32 (1951) (English edition).

1574. Kaemmerer, W., **Automatic regulation of warp tension,*** *Z. ges. Textil-Ind.* **54**, 1239–40, 1242 (1952).

1575. Leblanc, M., **Tension, friction, and extension of yarns during warping,*** *Rayonne et fibres synthét.* **8**, No. 2, 9–16; No. 3, 11–18 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 194–6, 242–8 (1952).

1576. Middlebrook, W., **The reed: Warp protectors,** *Textile Manufacturer* **78**, 356–7 (1952).

1577. Middlebrook, W., **The sley: Operation and function,** *Textile Manufacturer* **78**, 288–90 (1952).

1578. Muschamp, H. L., **The weft pirn,** *J. Text. Inst.* **43**, P793–813 (1952).

1579. Naumov, W. A., **Theory and procedure for adjustment of the pick of a loom according to the trajectory of the shuttle,*** *Textil-Praxis* **7**, 44–50 (1952).

1580. Noorlander, F., **Enkalon on the loom,** *Rayon Rev.* (special Enkalon issue), 59–61 (1952) (English edition).

1581. Schulze, J. A., **Perlon weaving,*** *Melliand Textilber.* **33**, 843–4 (1952).

1582. Schwabe, K., **When and why an open-shed dobby loom?*** *Textil-Praxis* **7**, 784–6 (1952).

1583. Wegmann, F., **A method for exact determination of the trajectory of the shuttle,*** *Textil-Praxis* **7**, 286–90 (1952).

F. *Knitting*

1584. Aberle, C., **"Knitting machines,"*** Wuppertal-Barmen, Spohr Verlag, 1951, 202 pp. (*J. Text. Inst.* **43**, A236 (1952)).

1585. Alexander, F. J., and Sturley, C. H., **Physical properties and specification testing of fully fashioned 15 denier monofil nylon stockings,** *J. Text. Inst.* **43**, P48–79 (1952).

1586. van den Bergh, B., **Directions for the processing of Enkalon on the cotton machine,** *Rayon Rev.* (special Enkalon issue), 52–3 (1952) (English edition).

1587. Bryant, F., **The ferroxyl reagent applied to a study of knitting needle corrosion,** TEXTILE RESEARCH JOURNAL **22**, 553–4 (1952) (Letter to the Editor).

1588. Gay, D. W., **Handling Orlon acrylic staple in knitted outerwear,** *Textile Age* **16**, No. 9, 68–71 (1952).

1589. Harrison, J., **Warp knitting machines and their products,** *Can. Text. J.* **69**, No. 7, 51–4 (1952).

MANUFACTURING

1590. Heukers, E., **Enkalon yarn on the knitting frame,** *Rayon Rev.* (special Enkalon issue), 54–6 (1952) (English edition).

1591. Hubach, F. F., **Uses for the newer fibers: Knit goods,** *Ind. Eng. Chem.* **44**, 2149–51 (1952).

1592. Ingham, J., **An experiment on the effect of yarn regain in machine knitting,** *J. Text. Inst.* **43**, P36–47 (1952).

1593. Kaufmann, W. B., **Up-to-date circular knitting machines,*** *Melliand Textilber.* **33**, 850–2, 1097–1100 (1952); **34**, 44 (1953).

1594. Malik, J. P., **Uses for the newer fibres: Pile fabrics,** *Ind. Eng. Chem.* **44**, 2147–9 (1952).

1595. Parr, K. H., **The knitting of blended yarns with special reference to footwear,** *J. Text. Inst.* **43**, P88–93 (1952).

See also [1270, 1284, 1299, 1404, 1938, 1980]

G. Nonwoven Fabrics

1596. Boese, A. W., **Bonded fabric development,** *Papers AATT* **7**, 141–4 (1952).

1597. Rähmer, H., **Non-woven textile sheet and molded structures: II,*** *Melliand Textilber.* **33**, 112–13 (1952).

1598. Shearer, H. E., **Methods of producing bonded-fiber fabrics,** *Am. Dyestuff Reptr.* **41**, P874–9 (1952).

1599. Shearer, H. E., **Nonwoven fabrics,** *Am. Dyestuff Reptr.* **41**, P429–31 (1952).

1600. Wrotnowski, A. C., **Some properties of thermoplastic fiber-bonded fabrics,** TEXTILE RESEARCH JOURNAL **22**, 480–6 (1952).

XII. DYEING AND FINISHING

A. General

1601. Abrams, E., **Waste disposal in the cotton textile industry,** *J. Southern Research* **4**, No. 1, 11–13 (1952) (*Chem. Abstracts* **46**, 5233d (1952)).

1602. de Araujo, A. A., **Application of ultrasonics to textile processes,** *Am. Dyestuff Reptr.* **41**, P615–19 (1952).

1603. Boyce, E. A. W., **Complaints common to a cotton textile converting plant,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 121–6.

1604. Colomb, P., **Origin of defects, stains, flaws in dyeing, printing, and finishing: Their detection, and means for avoiding and correcting them,*** *Teintex* **17**, 155, 157–8, 161, 226, 229, 231–2, 235, 551, 553–4, 557, 559 (1952).

1605. Diserens, L., **"The chemical technology of dyeing and printing,"** Vol. II, translated and revised from the second German edition by P. Wengraf and H. P. Baumann, New York, Reinhold Publishing Corp., 1951, 446 pp. (reviewed in TEXTILE RESEARCH JOURNAL **22**, 559 (1952)).

1606. Drane, C. W., **Industrial water treatment,** *Textile Manufacturer* **78**, 34–6 (1952).

1607. Haller, R., **"Dyeing and printing: Theoretical principles,"** * Vienna, Springer-Verlag, 1951, 236 pp.

1608. Haller, R., **Reactivating old processes in textile processing,*** *Melliand Textilber.* **33**, 1034–6 (1952).

1609. Happe, W., **What can the hydrogen bond mean to the colorist?** * *Reyon Zellwolle u. Chemiefasern* **30**, 286–95 (1952).

1610. Hausermann, J. L., **Natural reducing agents in textile-chemical processes,*** *SVF Fachorgan Textilveredl.* **5**, 213–20 (1950) (*J. Text. Inst.* **43**, A244 (1952)).

1611. Kraus, G., **Dangerous short cuts,** *Text. J. Australia* **26**, 1167–8 (1952).

1612. Kuisel, H. F., and Ott, R., **Problems of waste-liquor disposal in the textile industry,*** *Textil-Rundschau* **7**, 216–22 (1952).

1613. Murray, H. D. (editor), **"Colour in theory and practice,"** new edition, London, Chapman and Hall, 1952 (reviewed in *J. Text. Inst.* **43**, P769 (1952)).

1614. Salquain, J., **Ultrasonics and the textile industry,*** *Teintex* **17**, 377–8, 381, 383, 385, 387, 389 (1952).

1615. Slade, F. H., **Treatment of water for textile processing plant,** *Textile Manufacturer* **77**, 607–11 (1951); **78**, 3–7 (1952).

1616. Valko, E. I., **The principles of textile finishing,** TEXTILE RESEARCH JOURNAL **22**, 213–22 (1952).

1617. Voiutskii, S. S., and Peregudova, L. E., **Impregnation of fabrics with aqueous dispersions of hydrophobic substances: II: Determination of the heterocapillarity of closely woven fabrics,*** *Zhur. Priklad. Khim.* **24**, 984–8 (1951) (*J. Soc. Dyers and Colourists* **68**, 42 (1952)).

1618. Weber, F., **The significance of light in textile processing: Some physical and chemical effects of light rays,*** *Melliand Textilber.* **33**, 1113 (1952); **34**, 62–5 (1953).

1619. Weissbach, H., **Corrosion protection by cathodic polarization in the textile industry,*** *Melliand Textilber.* **33**, 445 (1952).

See also [1447, 1805, 1806, 1814]

B. Preliminary Processes

1. Desizing and Mercerizing

1620. Clark, J. A., and Losie, G. L., **Continuous desizing of cotton and rayon fabrics,** *Textile Inds.* **116**, No. 12, 110–13, 215 (1952).

1621. Dantal, L., **Enzymic reactions and their application for textiles,*** *Industrie textile* **69**, 450–6, 504–7 (1952) (*Chem. Abstracts* **47**, 865d (1953)).

1622. Goldthwait, C. F., Murphy, A. L., Lohmann, I. W., and Smith, H. O., **Mercerization of yarn: Experimental apparatus and techniques,** TEXTILE RESEARCH JOURNAL **22**, 540–8 (1952).

1623. Henk, J., **Mercerization of mixed fabrics of cotton and viscose rayon,*** *Reyon Zellwolle u. Chemiefasern* **30**, 181–2 (1952).

1624. Jülicher, W., **Enzymatic desizing of fabrics * (with reply by J. Voss),** *Melliand Textilber.* **33**, 511–17 (1952).

1625. Klemm, O., **Evaluation of enzyme desizing agents,*** *SVF Fachorgan Textilveredl.* **7**, 168–75 (1952) (*J. Text. Inst.* **43**, A813 (1952)).

1626. Stradley, J. H., Taylor, J. L., *et. al.*, **A study of the effects of fabric construction and mercerization on the light and wash fastness of vat dyes,** *Am. Dyestuff Reptr.* **41**, P173–6 (1952).

See also [291, 293]

2. Bleaching and Stripping

1627. Allen, T. G., **Bleaching of fabrics made from mixtures of cotton and rayon staple,*** *Rayonne et fibres synthét.* **7**, No. 11, 14–16 (1951).

1628. Bell, T. E., **Peroxide bleaching of cotton yarns and fabrics,** *Am. Dyestuff Reptr.* **41**, P79–82 (1952).

1629. Bell, T. E., and Stalter, N. J., **Characteristics of cotton fabrics processed in continuous peroxide bleaching systems,** *Am. Dyestuff Reptr.* **41**, P110–14 (1952).

1630. Bryner, M., **Bleaching with sodium chlorite,*** *SVF Fachorgan Textilveredl.* **7**, 157–68 (1952) (*Chem. Abstracts* **46**, 9853c (1952)).

1631. Flis, I. E., and Perl'shtein, E. IA., **Use of buffer substances in the bleaching of cellulose,*** *Zhur. Priklad. Khim.* **25**, 766–72 (1952) (*Faserforsch. u. Textiltech.* **3**, 421 (1952)).

1632. Frishman, D., and Harris, M., **The stripping of dyes from wool,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 70–2.

1633. Hall, A. J., **Finishing for the consumer: II: Production of brilliant whites,** *Rayon and Synthetic Texts.* **33**, No. 2, 63–4, 68 (1952).

1634. Hundt, W., and Vieweg, K., **Bleaching with sodium chlorite,*** *Tiba* **29**, No. 6, 24–7 (1952) (*Faserforsch. u. Textiltech.* **3**, 293 (1952)).

1635. Itina, O. E., **Rationalization of the bleaching process for linen fabrics,*** *Tekstil. Prom.* **9**, No. 9, 27–9 (1949) (*Chem. Abstracts* **46**, 4240a (1952)).

1636. Kartzow, E., **New possibilities to abbreviate the bleaching of linen goods,*** *Industrie textile* **69**, 381–5 (1952) (*Chem. Abstracts* **47**, 875b (1953)).

1637. Klein, A., **Automatic control in the bleaching of cotton,*** *Teintex* **17**, 503–4, 507, 509, 511, 513, 559–60, 563, 565–6, 569, 571, 573, 575 (1952).

1638. Kraemer, R., and Goldthwait, C. F., **Whites from chlorine and peroxide both "permanent,"** *Textile World* **102**, No. 3, 159, 246 (1952).

1639. Leclerc, J., **Stain and damage of fibers in bleaching cotton piece goods,*** *Industrie textile* **69**, 269–70 (1952) (*Chem. Abstracts* **46**, 11693e (1952)).

1640. Meybeck, J., **New developments in the chemistry of chlorite,*** *Teintex* **17**, 71–2, 75, 77–8, 81, 83–4, 87, 89–90, 93, 95, 97, 99 (1952).

1641. Meybeck, J., and Iwanow, N., **Tests of the resistance of various materials to corrosion by sodium chlorite liquors of use in the textile industry,*** *Bull. inst. text. France*, No. 36, 7–26 + 12 plates (1952).

1642. Mouton, J., **Bleachery technique,*** *Teintex* **17**, 643, 645, 647, 649, 651, 653, 655, 657, 659, 661 (1952).

1643. Nagatkin, I. G., **Activators for chlorine bleaches,*** *Tekstil. Prom.* **12**, No. 3, 23–4 (1952) (*Faserforsch. u. Textiltech.* **3**, 249 (1952)).

1644. Secord, R. A., **Application of peroxygen compounds in the textile industry,** *Am. Dyestuff Reptr.* **41**, P581–4 (1952).

1645. Sherburne, O. L., and Beiswanger, J. P. G., **Textile application of brighteners,** *Am. Dyestuff Reptr.* **41**, P144–8 (1952).

1646. Smolens, H. G., **Hydrogen peroxide bleaching of textile materials: A background of present-day procedures,** *Am. Dyestuff Reptr.* **41**, P575–7, P580 (1952).

1647. Voronkov, B. S., and Shchegoleva, R. M., **Rapid continuous bleach for low-grade cotton goods,*** *Tekstil. Prom.* **12**, No. 5, 29–32 (1952) (*J. Soc. Dyers and Colourists* **68**, 476 (1952)).

1648. Wood, W. S., and Richmond, K. W., **Recent developments in bleaching with hydrogen peroxide,** *J. Soc. Dyers and Colourists* **68**, 337–44 (1952).

See also [1187, 1188, 1454, 1712, 1715]

3. Carbonizing

1649. Anon., **Effect of carbonising processes on nylon yarn and fabric,** *Textile Manufacturer* **78**, 471–2 (1952); *Dyer* **108**, 269, 271 (1952).

1650. Azuma, N., Kuze, E., and Bekku, F., **Carbonization by radio-wave heating: I: Some properties of wool in high-frequency electric fields,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 374–6 (1950) (*Chem. Abstracts* **46**, 4804d (1952)).

1651. Azuma, N., Yamamoto, I., Bekku, F., Yamashita, F., and Niwa, Y., **Carbonization by radio-wave heating: II: Carbonization of burrs in felt,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 437–40 (1950) (*Chem. Abstracts* **46**, 4804e (1952)).

1652. Kittan, G., **Carbonization of piece goods with sulfuric acid,*** *Textil-Praxis* **7**, 447–9 (1952).

C. Dyeing

1. New Dyes

1653. Dierkes, G., **Dyeing with sulfur and Hydron dyes,*** *Rayonne et fibres synthét.* **8**, No. 12, 91, 93, 95, 97, 99, 101 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 638–42 (1952).

1654. Lieser, T., and Nischk, G., **Artificial organic high polymers: VI: High polymers with dyestuff characteristics,*** *Ann.* **569**, 66–74 (1950).

1655. Peter, F., **Modern black dyestuffs,*** *Reyon Zellwolle u. Chemiefasern* **30**, 352–6 (1952).

1656. Seidenfaden, W., **New dyestuffs: IV,*** *Melliand Textilber.* **33**, 218–21 (1952).

1657. Stead, E., and Murray, A., **Some developments in dispersed azo dyes for cellulose acetate rayon and nylon,** *J. Soc. Dyers and Colourists* **68**, 15–16 (1952).

1658. Sunthankar, S. V., and Gilman, H., **Silicon-containing azo dyes: III: Dyeing properties, absorption spectra, and pH range,** TEXTILE RESEARCH JOURNAL **22**, 574–83 (1952).

1659. Venkataraman, K., **"The chemistry of synthetic dyes,"** Vol. I. and Vol. II., New York, Academic Press, 1952, 1442 pp.

1660. Weidmann, C. J., **A new class of CIBA dyestuffs,** *Can. Text. J.* **69**, No. 23, 64–6 (1952).

2. Theoretical Papers

(a) Properties of Dyes

1661. Alexander, P., and Stacey, K. A., **The colloidal behaviour of dyes,** *Proc. Roy. Soc.* (London) **A212**, 274–90 (1952).

1662. Atherton, E., and Peters, R. H., **Some further investigations into the fading rates of monoazo dyes,** *J. Soc. Dyers and Colourists* **68**, 64–6 (1952).

1663. Bradley, W., Leete, E., and Nursten, H. E., **The properties of some derivatives of indanthrone and flavanthrone,** *J. Soc. Dyers and Colourists* **68**, 116–18 (1952).

1664. Brooker, L. G. S., White, F. L., Sprague, R. H., Dent, S. G., Jr., and van Zandt, G., **Steric hindrance to planarity in dye molecules,** *Chem. Revs.* **41**, 325–51 (1947).

1665. Chaudhuri, K. D., and Das Gupta, D. R., **On the molecular conductivity of dyestuffs in solution and the influence of foreign substances on the same,** *Indian J. Phys.* **26**, 67–78 (1952).

1666. Cranshaw, L., **Survey of recent theories of dyeing,** *Text. J. Australia* **26**, 1068–72 (1951).

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1667. Giles, C. H., and Neustadter, E. L., **Researches on monolayers: I: Molecular areas and orientation at water surfaces of aromatic azo compounds containing long alkyl chains,** *J. Chem. Soc.* **1952**, 918–23.

1668. Ikoma, I., and Shiozawa, K., **Relation between the chemical structure and the colloidal and dyeing properties of direct azo dyes: II: Azo dyes composed of chloronaphtholsulfonic acid and dehydrothio-*p*-toluidine,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 150–2 (1949) (*Chem. Abstracts* **46**, 3279i (1952)).

1669. Kuhn, H., **Electron gas model in the quantitative indication of light-absorption by organic dyestuffs II: Sec. A: Determination of intensity of absorption bands,*** *Helv. Chim. Acta* **34**, 1308–24 (1951) (in German).

1670. Kuhn, H., **Electron gas model in the quantitative indication of light-absorption by organic dyestuffs II: Sec. B: Disturbance of the electron gas by hetero-atoms,*** *Helv. Chim. Acta* **34**, 2371–2402 (1951) (in German).

1671. Luszczak, A., **Technically important extinction regularities of dyes,*** *Spectrochim. Acta* **5**, 41 (1952).

1672. Sen, A. B., and Sharma, R. C., **Studies on the solubility and light-fastness of azo dyes: I,** *J. Indian Chem. Soc.* **28**, 657–60 (1951).

1673. Sivarajan, S. R., **Scattering of light in colloidal dye solutions,** *Current Sci.* (India) **20**, 202–3 (1951) (Letter to the Editor).

1674. Tawde, N. R., and Ramanathan, N., **Fluorescence of dyestuff solutions: Viscosity and temperature effects,** *Proc. Phys. Soc.* (London) **B65**, 33–40 (1952).

1675. Wahl, H., **Relationship between color and molecular constitution,*** *Teintex* **17**, 207–8, 211, 213–14, 217, 219–20, 223–5 (1952).

(*b*) *Interaction of Dyes and Fibers*

1676. Benson, B., Kruger, J., Donovan, R., and Larose, P., **The effect of temperature on the sorption of Orange II by wool,** *Can. J. Technol.* **30**, 105–15 (1952).

1677. Elöd, E., **The dyeing process,*** *Textil-Praxis* **7**, 66–9 (1952).

1678. Flett, M. S.-C., **The heats and free energies of formation of some hydrogen bonds,** *J. Soc. Dyers and Colourists* **68**, 59–64 (1952).

1679. Fröhlich, H. G., **The direct absorption of acid and Palatine dyes by synthetic protein fibers as compared with that of wool and polyamides, at various pH values,*** *Deut. Textilgewerbe* **53**, 829–31 (1951).

1680. Fujita, H., and Kishimoto, A., **Diffusion with adsorption to apply to the dyeing theory of fibers,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 244–9 (1952) (*Chem. Abstracts* **46**, 9311g (1952)).

1681. Harrison, W., **Absorption of direct dyes by cellulose,** *Chemistry & Industry* **1952**, 758–9 (Letter to the Editor).

1682. Harrison, W., **The combination of wool with acids,** *J. Soc. Dyers and Colourists* **68**, 176–8 (1952) (Letter to the Editor).

1683. Jackson, J. H. E., and Turner, H. A., **The desorption of a direct cotton dye from cellulosic fibres,** *J. Soc. Dyers and Colourists* **68**, 345–52 (1952).

1684. Klotz, I. M., Burkhard, R. K., and Urquhart, J. M., **The binding of organic ions by proteins: Comparison of bovine and human serum albumins,** *J. Phys. Chem.* **56**, 77–85 (1952).

1685. Kruger, J., Donovan, R., and Larose, P., **Observations on the sorption of Orange II by wool,** *Can. J. Technol.* **30**, 215–21 (1952).

1686. Nishida, K., **Donnan membrane equilibrium and direct dyeing of Cellophane: I and II,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 539–44 (1951) (*Chem. Abstracts* **46**, 6389c (1952)).

1687. Sadov, F. I., and Kalinina, K. G., **The theory of dyeing cellulose fibers by direct dyes: I: The effect of functional groups on the color uptake by cellulose,*** *Tekstil. Prom.* **11**, No. 11, 36–8 (1951); *Kolloid Zhur.* **14**, 118–23 (1952) (*Chem. Abstracts* **46**, 6388d (1952)).

1688. Sokolova, N. V., **Theory of dyeing: XIII: Effect of pH of the dye-bath on binding of acid and substantive dyes by wool keratin,*** *Zhur. Priklad. Khim.* **21**, 966–75 (1948) (*Chem. Abstracts* **46**, 2806g (1952)).

1689. Standing, H. A., **The equilibrium absorption of direct dyes by cellulose materials,** *Chemistry & Industry* **1952**, 527–30.

1690. Tanaka, R., and Murayama, T., **Dyeing of cellulose acetate fibers: VII: Dyeing with indigo (mechanism),*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 194–6 (1952) (*Chem. Abstracts* **46**, 8858i (1952)).

1691. Tanaka, R., and Seko, K., **Dyeing of cellulose acetate fibers: VI: Dyeing with indigo (dispersion),*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 192–4 (1952) (*Chem. Abstracts* **46**, 8858h (1952)).

1692. Tanaka, R., Seko, K., and Murayama, T., **Dyeing of cellulose acetate fibers: V: Dyeing with indigo,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 124–6 (1952) (*Chem. Abstracts* **46**, 8858g (1952)).

1693. Wahl, H., Arnould, Y., and Simon, M., **Relationship between the constitution of certain azoic dyes and their ability to dye acetate,*** *Teintex* **17**, 288, 291, 293–4 (1952).

1694. Wüterich, W., **The problem of fastness to crocking in naphthol dyeings,*** *SFV Fachorgan Textilveredl.* **7**, 207–11, 268–73 (1952); *Melliand Textilber.* **33**, 743–7 (1952).

(*c*) *Miscellaneous*

1695. Boulton, J., and Crank, J., **Package dyeing: I: A theoretical model and its relation to technical practice,** *J. Soc. Dyers and Colourists* **68**, 109–16 (1952).

1696. Haller, R., **The relativity of the term "fixation" in textile processes,*** *Textil-Praxis* **7**, 73–5 (1952).

1697. Lomas, H., **Modern dyeing theories in relation to the function of levelling agents in wool dyeing,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 64–9.

1698. Morton, T. H., **Application of research ideas to some aspects of dyeing and finishing,** *Can. Text. J.* **69**, No. 14, 53–6, 59 (1952).

1699. Talanina, A. S., and Milinskii, N. A., **Dye penetration of cotton fabrics,*** *Tekstil. Prom.* **9**, No. 10, 26–9 (1949) (*Chem. Abstracts* **46**, 4233h (1952)).

1700. Wegmann, J., **Developments in research and application of direct dyes,*** *Teintex* **17**, 275–6, 279, 281–2, 285, 287 (1952).

3. Wool

1701. Anon., **Penetration of astrakans: Improved results with direct and neutral dyes,** *Dyer* **108**, 247–8 (1952).

1702. Berezina, V. A., **Dyeing of woolen fabrics with vat dyes,*** *Tekstil. Prom.* **9**, No. 9, 29–30 (1949) (*Chem. Abstracts* **46**, 4234h (1952)).

1703. Bhat, G. N., and Rao, M. R. A., **Chrome-mordanting of wool,** *J. Sci. Ind. Research* (India) **11B**, 67–75 (195.).

1704. Carpenter, A., **Some useful dyes for wool knitwear,** *Textile Recorder* **69**, No. 826, 86–8 (1952).

1705. Casty, R., **The theory and practice of wool dyeing with acid chrome dyestuffs,*** *Melliand Textilber.* **33**, 950–4 (1952).

1706. Grundy, J. G., **Cibalan dyes on wool,** *Dyer* **108**, 685–92 (1952).

1707. Haigh, D., **Colour, hats and trimmings,** *Dyer* **107**, 709–12 (1952).

1708. Jensen, J., **The significance of the oil content of wool in dyeing,*** *Tids. Textilteknik* **10**, 1–4 (1952).

1709. Jones, L. W., **Colour selection in relation to successful dyeing,** *Text. J. Australia* **27**, 190–2 (1952).

1710. Justice, J. D., and Ewing, W. W., **The role of sodium chloride and sodium sulfate in acid-dyeing wool,** *Am. Dyestuff Reptr.* **41**, P668–77 (1952).

1711. Leitch, H. W., **Interchangeability of sodium sulfate and common salt in acid-dyeing wool,** *Am. Dyestuff Reptr.* **41**, P678–81 (1952).

1712. Ogden, W. H., **Simultaneous stripping and dyeing of wool both in the stock and on pieces,** *Textile Age* **16**, No. 1, 30–3 (1952).

1713. van Overbeke, M., Mazingue, C., and Laloy, R., **Protection of wool with proteinaceous agents during dyeing,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 141–53 (in French).

1714. Preston, C., **Surface-active dyes,** *Hexagon Digest*, No. 11, 31–2 (1952).

1715. Prisley, F. A., **Ogden process for simultaneously stripping and dyeing wool,** *Am. Dyestuff Reptr.* **41**, P251–2 (1952).

1716. Rattee, I. D., **Level dyeing of acid dyes: Practical importance of basicity: Carbolan salt A,** *Dyer* **107**, 641–2 (1952).

1717. Rostovtsev, V. E., **Improved dyeing of protein fibers with ice colors,*** *Tekstil. Prom.* **10**, No. 11, 38–9 (1950) (*Chem. Abstracts* **46**, 6388g (1952)).

1718. Speiser, C. T., **Application of Indigosols to wool, wool-cotton unions, acetate rayon, and polyvinylchloride fibers,*** *SVF Fachorgan Textilveredl.* **6**, 399–405 (1951) (*J. Text. Inst.* **43**, A242 (1952)).

1719. Story, L. F., **The effect of copper in wool dyeing,** *J. Soc. Dyers and Colourists* **68**, 512 (1952) (Letter to the Editor).

1720. Wojatschek, K., **The dyeing of cheeses of yarns composed wholly or partly of wool,*** *Melliand Textilber.* **33**, 430–3 (1952).

1721. Wojatschek, K., **The dyeing of Zycon and wool/Zycon mixtures with wool dyes,*** *Textil-Praxis* **7**, 986–8 (1952).

4. Cellulosic Fibers

(a) Cotton and Viscose Rayon

1722. Belen'kii, L. I., Rakhlina, S. S., and Kazanskaia, M. E., **Rationalization of azoic dyeing,*** *Tekstil. Prom.* **9**, No. 12, 25–8 (1949) (*Chem. Abstracts* **46**, 4234f (1952)).

1723. Cambier, H., **Dyeing of viscose fibers on crossed bobbins with indanthrene-type vat dyes,*** *Efficience textile* **6**, No. 11, 28–31 (1951) (*Chem. Abstracts* **46**, 5847i (1952)).

1724. Cates, D. M., Campbell, K. S., and Rutherford, H. A., **Relation between certain defects in dyed fabrics and mechanical damage in wet processing,** TEXTILE RESEARCH JOURNAL **22**, 623–30 (1952).

1725. Daruwalla, E. H., and Nabar, G. M., **A new method for the dyeing of mineral khaki,** *J. Soc. Dyers and Colourists* **68**, 168–70 (1952).

1726. Fox, M. R., **Fastness of cotton dyeings,** *Dyer* **107**, 489–93 (1952).

1727. Guthrie, J. D., **Attachment of dyes to cotton by ether linkage,** *Am. Dyestuff Reptr.* **41**, P13–14, 30 (1952).

1728. Henderson, J., and Sokol, W. M., **The blinding of viscose rayon with azoic dyestuffs,** *Hexagon Digest*, No. 12, 15–21 (1952).

1729. Henk, H.-J., **Causes of uneven dyeings on viscose rayon,*** *Textil-Praxis* **7**, 543–4 (1952).

1730. Ikeda, S., and Fukui, Y., **Practical application of vat dyes to yarn dyeing,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 21–3 (1951) (*Chem. Abstracts* **46**, 6389a (1952)).

1731. Lister, G. H., **Resin aftertreatments of direct cotton dyes,** *Textile Recorder* **69**, No. 829, 85–6; **70**, No. 831, 89–90 (1952).

1732. Nishida, K., **Direct dyeing of cellulose: II: Dyeing properties of Aizen Direct Blue BBH, Diamine Blue 3B, and Nippon Sky Blue,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 463–6 (1952) (*Chem. Abstracts* **47**, 321h (1953)).

1733. Nitschke, G., **Continuous dyeing of rayon top and sliver,*** *Textil- u. Faserstofftech.* **2**, 69–71 (1952) (*Faserforsch. u. Textiltech.* **3**, 249 (1952)).

1734. Nitschke, G., **The damage and solubility of viscose rayon during dyeing with sulfur colors,*** *Faserforsch. u. Textiltech.* **3**, 66–72 (1952).

1735. Plaksin, S. A., and Makarova, A. S., **Washing off printed naphtholated fabrics,*** *Tekstil. Prom.* **12**, No. 5, 33–4 (1952) (*J. Soc. Dyers and Colourists* **68**, 478 (1952)).

1736. Rinneberg, K. A., **The dyeing of native and regenerated cellulose fibers in mechanical apparatus: III: Mechanical dyeing apparatus for warp beams and card slivers,*** *Textil-Praxis* **6**, 889–93 (1951).

1737. Rogovin, Z. A., IAshunskaia, A. G., and Bogoslavskii, B. M., **Preparation of chemically dyed fiber,*** *Zhur. Priklad. Khim.* **23**, 631–41 (1950) (*Chem. Abstracts* **46**, 4235g (1952)).

1738. Somers, J. A., **Some unexplained peculiarities of viscose rayon: Dyeing phenomena in relation to swelling and stretching,** *Brit. Rayon and Silk J.* **29**, No. 340, 46, 48–9 (1952).

1739. Toepffer, H., **After-treatment of dyed materials,*** *SVF Fachorgan Textilveredl.* **6**, 405–10 (1951) (*J. Text. Inst.* **43**, A242 (1952)).

1740. Vago, G. J., **Rubbing fastness problem in naphtol dyeings,** *Text. J. Australia* **27**, 1185–90 (1952).

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1741. Waldie, W. J., **Advances in the application of fast direct dyestuffs on cotton,** *Can. Text. J.* **69**, No. 24, 63–7 (1952).

(*b*) *Acetate Rayon*

1742. Bertolina, G., **Dyeing of acetate filament,*** *Rayonne et fibres synthét.* **8**, No. 1, 11–26 (1952).

1743. Carmichael, D. G., and Ivey, W. R., Jr., **New developments in dyeing cellulose-acetate yarn,** *Am. Dyestuff Reptr.* **41**, P424–5, P428 (1952).

1744. Fortess, F., and Ward, G. C., **Dyeing, finishing of fabrics containing acetate filament and/or staple fibre,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 101–9.

1745. Salvin, V. S., Paist, W. D., and Myles, W. J., **Advances in theoretical and practical studies of gas fading,** *Am. Dyestuff Reptr.* **41**, P297–302 (1952).

1746. Tanaka, R., and Shinohara, T., **Dyeing of cellulose acetate: IV: Dyeing with indigo,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 510–12 (1951) (*Chem. Abstracts* **46**, 6389b (1952)).

See also [1718, 1724, 1840]

5. *Synthetics*

1747. Anon., **Dyeing Dacron polyester fiber,** *Textile Age* **16**, No. 10, 36–42 (1952).

1748. Anon., **Dyeing Orlon acrylic fiber,** *Textile Age* **16**, No. 10, 22–31 (1952).

1749. Baron, A.-M., **The dyeing of fibers made of addition high polymers,*** *Teintex* **17**, 690, 693, 695–6, 699, 701–2, 705, 707 (1952).

1750. Baron, A.-M., **Practical and theoretical considerations of the dyeing of vinyl fibers,*** *Teintex* **17**, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55 (1952).

1751. Baumann, H. P., **Problems presented by the new fibers,** *Am. Dyestuff Reptr.* **41**, P453–6 (1952).

1752. Blaker, R. H., **Copper sulfate reduction,** *Modern Textiles Mag.* **33**, No. 11, 56, 58, 60 (1952).

1753. Blaker, R. H., and Laucius, J. F., **The copper method for dyeing Orlon acrylic fiber,** *Am. Dyestuff Reptr.* **41**, P39–43 (1952).

1754. Choquette, P. J., **Dyeing the newer fibers,** *Modern Textiles Mag.* **33**, No. 10, 31, 60, 62, 68 (1952).

1755. De Turck, H. L., **The dyeing and finishing of hosiery,** *Am. Dyestuff Reptr.* **41**, P739–43 (1952).

1756. Feild, T. A., Jr., **The dyeing of Dynel and related products,** *Am. Dyestuff Reptr.* **41**, P475–8 (1952).

1757. Fidell, L. I., **Dyeing and processing of nylon fabrics,** *Can. Text. J.* **69**, No. 6, 53–4, 57–60, 63–7, 89 (1952); *Textile Age* **16**, No. 4, 32–4, 37–45; No. 5, 46–51 (1952).

1758. Fronmuller, G. D., **Some of the variables connected with the dyeing of Orlon,** *Am. Dyestuff Reptr.* **41**, P578–80 (1952); *Can. Text. J.* **69**, No. 16, 53–6 (1952).

1759. Gamble, E. H., Parks, W. G., *et al.*, **The continuous dyeing of new synthetic fibers,** *Am. Dyestuff Reptr.* **41**, P223–41 (1952).

1760. Hadfield, H. R., and Mills, P., **Azoic dyes on nylon,** *Hexagon Digest*, No. 11, 18–24 (1952).

1761. Joly, P., **Details on the dyeing of hydrophobic fibers,*** *Teintex* **17**, 139–40, 143, 145–6, 149, 151–2, 155 (1952).

1762. Karafiat, E., **Dyeing and finishing of Perlon or nylon stockings,*** *Melliand Textilber.* **33**, 314–17, 1033–4 (1952).

1763. Klopfstock, C., **The dyeing of polyamide fibers and their mixtures with wool or regenerated cellulose,*** *SVF Fachorgan Textilveredl.* **6**, 325–31 (1951) (*J. Text. Inst.* **43**, A244 (1952)).

1764. Leggett, W. F., **New dye techniques for new fibers,** *Modern Textiles Mag.* **33**, No. 9, 74, 122 (1952).

1765. Lutgerhorst, A. G., **The dyeing of Enkalon woven and knitted goods,** *Rayon Rev.* (special Enkalon issue), 68–70 (1952) (English edition).

1766. Müller, L. W., **Dyeing Perlon and nylon, alone and in mixtures with other fibers: Various important characteristics of polyamide fibers,*** *SVF Fachorgan Textilveredl.* **7**, 20–5, 65–70, 108–12 (1952) (*Chem. Abstracts* **47**, 322e (1953)).

1767. Remington, W. R., **Principles of dyeing "Dacron" polyester fiber,** *Am. Dyestuff Reptr.* **41**, 859–60 (1952).

1768. Runting, R. L., **Some dyeing problems with new fibres,** *Text. J. Australia* **27**, 825–8 (1952).

1769. Somers, J. A., **Dyeing synthetic fibres: Recent advances in applications of copper compounds,** *Brit. Rayon and Silk J.* **28**, No. 335, 68–9 (1952).

1770. Speiser, C. T., **Dyeing polyamide fibers with Indigosols,** *Am. Dyestuff Reptr.* **41**, 349–50 (1952); *Textil-Rundschau* **7**, 370–1 (1952).

1771. Szlosberg, E., **Dyeing Orlon,** *Am. Dyestuff Reptr.* **41**, P510–16 (1952).

1772. Turnbull, S. G., Jr., **The dyeing of nylon, Orlon acrylic fiber and Dacron polyester fiber,** *Am. Dyestuff Reptr.* **41**, P75–8, P82 (1952).

1773. White, G. S. J., **The dyeing of new fibers,*** *Textil-Rundschau* **7**, 12–23 (1952).

1774. Woodruff, J. A., **Acrilan acrylic fibre dyeing and finishing,** *Can. Text. J.* **69**, No. 11, 58–63 (1952).

See also [1718]

6. *Blends*

1775. Früh, G., **Tone-on-tone dyeing of Perlon-rayon yarns and fabrics,*** *Reyon Zellwolle u. Chemiefasern* **30**, 175–80 (1952).

1776. Groves, C. S., and Ward, C. F., **Dyeing in the blended fibre hosiery industry with some observations on finishing,** *J. Text. Inst.* **43**, P626–47 (1952).

1777. Morris, M. G., **Dyeing of materials for plain and face-finished auto fabrics,** *Am. Dyestuff Reptr.* **41**, P479–81 (1952).

1778. Stewart, J. R., **Dyeing of wool-rayon unions,** *Can. Text. J.* **69**, No. 12, 60–3; No. 14, 61–3 (1952).

1779. van Thourout, C., **The dyeing and finishing of fabrics of synthetic fibers and of mixtures of cotton and synthetic fibers,*** *Reyon Zellwolle u. Chemiefasern* **30**, 592–602 (1952); *Rayonne et fibres synthét.* **8**, No. 12, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71–3 (1952).

1780. Wojatschek, K., **Application of benzo-fast copper dyestuffs in half-wool dyeing,*** *Melliand Textilber.* **33**, 157–60 (1952).

1781. Wojatschek, K., **Half-wool dyeing and its difficulties with regard to modern mixed fabrics,*** *Textil-Praxis* **7**, 385–8, 461–3 (1952).

See also [1718, 1720, 1763, 1766]

7. High-Temperature Dyeing and Other New Developments

(a) High-Temperature Processes

1782. Cole, P. M., **Pressurized fabric dyeing,** *Dyer* **108**, 925, 927, 929, 931, 933, 935 (1952); *Am. Dyestuff Reptr.* **42**, P32–5 (1953).
1783. Cole, P. M., **Revolution in batch dyeing,** *Modern Textiles Mag.* **33**, No. 9, 76–7, 107–8 (1952).
1784. Drijvers, L., **The dyeing of textile fibers at high temperature,** *Am. Dyestuff Reptr.* **41**, 533–9 (1952); *Melliand Textilber.* **33**, 525–31 (1952); *Teintex* **17**, 294, 297, 299–300, 303, 305, 307, 309, 311, 313 (1952).
1785. Herrmann, E., **Direct dyestuffs suitable for application at temperatures above 100° C,*** *Melliand Textilber.* **33**, 1110–12 (1952).
1786. Hünlich, R., **The new hot oil continuous dyeing process,*** *Reyon Zellwolle u. Chemiefasern* **30**, 154 (1952); *Rayonne et fibres synthét.* **8**, No. 8, 39–40 (1952).
1787. Kramrisch, B., **Dyeing the modern synthetic fibres,*** *Dyer* **108**, 709, 711, 713 (1952).
1788. Roy, A. P., **Some practical procedures for dyeing cotton and for the high-temperature dyeing of synthetic fibers,** *Am. Dyestuff Reptr.* **41**, P844–6 (1952).
1789. Swillens, P., **The influence of temperature on dyeing and the use of dyeing temperatures exceeding 100°,*** *Rayonne et fibres synthét.* **8**, No. 4, 43, 45–7, 49 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 133–6 (1952).

(b) New Methods in Vat Dyeing

1790. Ardron, J., Fox, M. R., and Speke, R. W., **The continuous dyeing of vat dyes: The Standfast molten metal technique,** *J. Soc. Dyers and Colourists* **68**, 249–56 (1952).
1791. Bräuer, M., **The stock-vat-exhaust process for machine dyeing with Indanthren dyestuffs,*** *Melliand Textilber.* **33**, 623–6 (1952).
1792. Fox, M. R., **The pad-stream process,** *Dyer* **108**, 833–6 (1952).
1793. Hoton, P., **Vat dyeing in metal bath,*** *Reyon Zellwolle u. Chemiefasern* **30**, 190–2 (1952).
1794. Lineken, E. E., Grand, S., and Fordemwalt, F., **Controlled vat dyeing: III: Leuco potentials,** *Am. Dyestuff Reptr.* **41**, 608–10 (1952).
1795. Marnon, D. E., **The hot-oil process,** *Rayon and Synthetic Texts.* **33**, No. 7, 57–8, 60 (1952).
1796. Marnon, D. E., **The Marhen Process,** *Am. Dyestuff Reptr.* **41**, P292–6 (1952).
1797. Marshall, W. J., and Peters, R. H., **The reduction properties of vat dyes,** *J. Soc. Dyers and Colourists* **68**, 289–99 + 3 plates (1952).
1798. Peters, R. H., and Marshall, W. J., **Measuring and practical significance of redox potentials of vat dyes,*** *Bull. inst. text. France*, No. 30, 415–38 (1952).
1799. Rath, J., **Potentiometric control of dyeing,*** *Melliand Textilber.* **33**, 862–4 (1952).
1800. Reiner, I., **Continuous dyeing of vat colors by the pad-steam process,** *Am. Dyestuff Reptr.* **41**, P44–6 (1952).
1801. Royer, G. L., **Controlled vat dyeing: II: Instrumental and analytical measurement,** *Am. Dyestuff Reptr.* **41**, 601–8 (1952).
1802. Solov'ev, N. P., **Stability of hydrosulfite in aqueous solutions,*** *Tekstil. Prom.* **12**, No. 7, 34–5 (1952) (*J. Soc. Dyers and Colourists* **69**, 69 (1953)).
1803. Zimmerman, C. L., Mecco, J. M., Fordemwalt, F., and Cooke, T. F., **Controlled vat dyeing: I: The stabilization of vat dyes at elevated temperatures,** *Am. Dyestuff Reptr.* **41**, 597–601 (1952).

See also [1702]

(c) Other New Processes

1804. Anon., **The Estrocon process: Hydrolysable ester controls dyebath pH, improves levelling of some colours on wool and nylon,** *Dyer* **107**, 783 (1952).
1805. Azami, T., and Hinohara, T., **The discoloration of a solution of dye by ultrasonic waves: I: An azo dye,*** *J. Chem. Soc. Japan*, Pure Chem. Sect., **72**, 453–5 (1951) (*Chem. Abstracts* **46**, 1843c (1952)).
1806. Azami, T., and Hinohara, T., **The discoloration of a solution of dye by ultrasonic waves: II: Triphenylmethane dyes,*** *J. Chem. Soc. Japan*, Pure Chem. Sect., **72**, 515–17 (1951) (*Chem. Abstracts* **46**, 6479d (1952)).
1807. Cayce, C. C., **New dyeing methods,** *Am. Dyestuff Reptr.* **41**, P426–8 (1952).
1808. Ernst, W., **Open-width dyeing processes,*** *Textil-Rundschau* **7**, 411–19 (1952).
1809. Gorshkov, P. V., **The ways of intensification of Aniline Black dyeing,*** *Ivanov. Nauch.-Issledovatel. Inst. Khlopchatobumazh. Prom., Nauch.-Issledovatel. Trudy* **18**, 100–8 (1951) (*Chem. Abstracts* **46**, 9850f (1952)).
1810. Hannay, R. J., Major, W. H., and Pickin, R., **A new method of pH control in dyeing and some observations on the metachrome process,** *J. Soc. Dyers and Colourists* **68**, 373–80 (1952).
1811. Liebsch, K., **Time and temperature control in piece dyeing,*** *Melliand Textilber.* **33**, 217 (1952).
1812. Lister, G. H., **The pH control of acid and chrome dyeing: II: Single-bath mordant dyeing,** *J. Soc. Dyers and Colourists* **68**, 49–57 (1952).
1813. Plaksin, S. A., and Vikhlyantsev, P. G., **Dyeing of sulfur dyes with steaming,*** *Ivanov. Nauch.-Issledovatel. Inst. Khlopchatobumazh. Prom., Nauch.-Issledovatel. Trudy* **18**, 90–9 (1951) (*Chem. Abstracts* **46**, 9850a (1952)).
1814. Rath, H., and Merk, H., **The influence of sound waves on dyeing,*** *Melliand Textilber.* **33**, 211–16, 311–14, 859–61 (1952).
1815. They, G. G., **Automatic temperature and cycle control in textile-dyeing machines,*** *Tinctoria* **49**, 221–6, 255–60, 293–7 (1952) (*Chem. Abstracts* **47**, 870i (1953)).
1816. Williams, S. H., **Continuous fiber dyeing,** *Am. Dyestuff Reptr.* **41**, P360–4 (1952).
1817. Zuber, C., **The application of pH and rH in dyeing,*** *Teintex* **17**, 347–8, 351, 353–4, 357, 359–60, 363, 365–6, 369, 371–2, 375 (1952).
1818. Zuber, C., and Jomain, B., **Use of sulphamic acid derivatives in the application of oxidation blacks,** *J. Soc. Dyers and Colourists* **68**, 241–8 (1952).

See also [1602, 1614]

8. Testing

(a) Color Measurement and Matching

1819. Buc, G. L., **Further tables for use in computing small color differences,** *Am. Dyestuff Reptr.* **41**, 353–5 (1952).

DYEING AND FINISHING

1820. Davidson, H. R., **Prediction of the color of dye mixtures on textiles,** *J. Optical Soc. Am.* **42**, 331–2 (1952).

1821. Derby, R. E., Jr., **Applied spectrophotometry: I: Color matching with the aid of the "R" cam,** *Am. Dyestuff Reptr.* **41**, P550–7 (1952).

1822. Friele, L. F. C., **The application of colour measurement in relation to fibre-blending,** *J. Text. Inst.* **43**, P604–11 (1952).

1823. Glasser, L. G., and Troy, D. J., **A new high sensitivity differential colorimeter,** *J. Optical Soc. Am.* **42**, 652–60 (1952).

1824. Goeroldt, H., Richter, M., and Weise, H., **Investigations on the exactness of visual color measurements of dyed shades on silk,*** *Melliand Textilber.* **33**, 335–8, 454–7 (1952).

1825. de Hauss, J. L., **Color matching by photocolorimetric methods,*** *Rayonne et fibres synthét.* **8**, No. 6, 73, 75, **77**, 79, 81–3 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 423–6 (1952).

1826. Niederhauser, J.-P., **The characterization and matching of colors: Colorimetry: Practical applications in the textile and dyeing field: II: Applications,*** *Teintex* **17**, 3–4, 7, 9–10, 13, 15–16, 19, 21–2, 25, 27, 29, 31 (1952).

1827. Nishida, K., **Direct dyeing of cellulose: I: Construction of a photoelectric color meter and direct dyeing,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 347–50 (1952) (*Chem. Abstracts* **46**, 9851c (1952)).

1828. Péters, O., **Tristimulus color measurement in dyeing,*** *Bull. inst. text. France*, No. 30, 91–106 (1952).

1829. Pritchard, B. S., and Stearns, E. I., **Dye control with the *R*-cam and ruler,** *J. Optical Soc. Am.* **42**, 752–3 (1952).

1830. Reese, W. B., **Practical color matching,** *Rayon and Synthetic Texts.* **33**, No. 3, 31–2, 78 (1952).

1831. Selling, H. J., and Friele, L. F. C., **The measurement of color,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 437–48 (in Dutch).

1832. Whyte, G. S. J., Vickerstaff, T., and Waters, E., **Standardization of colors in dyeing,*** *Tinctoria* **49**, 153–6, 187–90 (1952) (*Chem. Abstracts* **46**, 11690c (1952)).

(*b*) *Fastness Determination*

1833. AATCC Research Committee on Simplified Wet Control Tests, **Rapid control test—Combined colorfastness and shrinkage equivalent to five commercial launderings** (Tentative test method 72–52), *Am. Dyestuff Reptr.* **41**, P560 (1952).

1834. AATCC Research Committee on Simplified Wet Control Tests, **Rapid control test to indicate colorfastness to 105° F washing** (Tentative test method 68–51), *Am. Dyestuff Reptr.* **41**, P34 (1952).

1835. AATCC Research Committee on Simplified Wet Control Tests, **Rapid control test to indicate colorfastness to perspiration** (Tentative test method 71–52), *Am. Dyestuff Reptr.* **41**, P559 (1952).

1836. Davidson, H. R., **A simple solution to the "artificial light" problem,** *Am. Dyestuff Reptr.* **41**, 1–10 (1952).

1837. Eaton, J. C., Giles, C. H., and Gordon, M., **Quantitative relationship between depth of dyeing and light fastness,** *J. Soc. Dyers and Colourists* **68**, 394–6 (1952) (Letter to the Editor).

1838. Gasser, F., and Zukriegel, H., **"Heliotest": A new, rapid testing apparatus for lightfastness,*** *Melliand Textilber.* **33**, 44–6 (1952).

1839. Goeb, A., **On the state of the determination of lightfastness of dyes,*** *Chem.-Ztg.* **76**, 433–6 (1952).

1840. Greyborn, A., **Testing colour fastness of dyed acetate to atmospheric gas fading,** *Can. Text. J.* **69**, No. 12, 64, 67 (1952).

1841. Hoffmann, K., **A new apparatus for testing fastness to light,*** *Melliand Textilber.* **33**, 1040–3, 1121–4 (1952).

1842. Luszczak, A., and Zukriegel, H., **On the spectral sensitiveness of light-resisting coal tar colors,*** *Melliand Textilber.* **33**, 535–7 (1952).

1843. McLaren, K., **The spacing of scales for assessing the effect on the pattern in fastness testing,** *J. Soc. Dyers and Colourists* **68**, 203–4 (1952).

1844. McLaren, K., **The use of the grey scale for assessing the effect on the pattern in fastness testing,** *J. Soc. Dyers and Colourists* **68**, 205–6 (1952).

1845. Miller, O. E., **Integrating light meter for fading tests,** *J. Optical Soc. Am.* **42**, 661–2 (1952).

1846. Oda, R., Isoda, K., Morita, N., and Kawata, M., **Photoöxidation: IV: Direct cotton dyes,*** *J. Soc. Org. Synthetic Chem.* (Japan) **7**, 204–5 (1949) (*Chem. Abstracts* **47**, 44g (1953)).

1847. Oliver, P. H., **A light-time integrator for use in daylight fading,** *J. Soc. Dyers and Colourists* **68**, 178–9 (1952) (Letter to the Editor).

1848. Rabe, P., **General directions for the determination of dye-fastness in textiles,*** *Melliand Textilber.* **33**, 70–83 (1952).

1849. Ricketts, R. H., **The rates of fading of the S.D.C. light fastness standards (B.S. 1006),** *J. Soc. Dyers and Colourists* **68**, 200–3 (1952).

1850. Society of Dyers and Colourists (Fastness Tests Coordinating Committee), **Method of test for determining the fastness to daylight of coloured textiles,** *J. Soc. Dyers and Colourists* **68**, 197–200 (1952).

1851. Swiss Standards Association, **Textiles: Textile testing methods,** *Am. Dyestuff Reptr.* **41**, P701–17 (1952).

1852. Zuber, C., **The determination of dye fastness and its standardization: Actual state of the question,*** *Teintex* **17**, 708, 711, 713, 715, 717–18, 723 (1952).

See also [963, 1671, 1726]

D. Printing

1853. Anon., **Dyestuff contamination detector,** *Dyer* **108**, 31–3 (1952).

1854. Balashev, P. S., **The stability of Rongalite,*** *Tekstil. Prom.* **10**, No. 2, 35–6 (1950); *Chem. Zentr.* **1950**, II, 1176 (*Chem. Abstracts* **46**, 10630i (1952)).

1855. Barella, A., **Contribution to the study of screen printing,*** *Bull. inst. text. France*, No. 30, 451–66 + 1 p. figure (1952).

1856. Bernardy, G., **Problems in screen printing with vat dyestuffs: I: Drying,*** *Melliand Textilber.* **33**, 628–33 (1952).

1857. Bernardy, G., **Problems in screen printing with vat dyestuffs: II: Steaming,*** *Melliand Textilber.* **33**, 865–7 (1952).

1858. Eber, H., **Lytax textiloscope,*** *Melliand Textilber.* **33**, 764–6 (1952).

1859. Fedorova, N. E., and Migacheva, I. B., **Development of diazaminols (Rapidogens) in the neutral ager,*** *Tekstil. Prom.* **11**, No. 8, 22–4 (1951) (*J. Soc. Dyers and Colourists* **68**, 40 (1952)).

1860. Haller, A., **Practical experiences in printing with pigment dyestuffs,*** *Melliand Textilber.* **33**, 317–19 (1952).

1861. Hoton, P., **Stabilized azoic dyes and their use in printing cellulosic fibers,*** *Rayonne et fibres synthét.* **8**, No. 12, 115, 117, 119, 121, 123, 125 (1952).

1862. Jacobs, F. F., **Continuous dyeing method in vat color printing,** *Am. Dyestuff Reptr.* **41**, 441–2 (1952).

1863. Jacobs, F. F., **"Textile printing,"** New York Chartwell House, Inc., 1952, 219 pp. (reviewed in TEXTILE RESEARCH JOURNAL **22**, 764 (1952)).

1864. Kertscher, W., **The Batik industry of Java,*** *Melliand Textilber.* **33**, 222–6, 435–8, 634–6, 868–70 (1952).

1865. Kozlov, B. A., **Prerequisites for the reduction of steam consumption in reducing agers,*** *Tekstil. Prom.* **12**, No. 6, 31–4 (1952) (*J. Soc. Dyers and Colourists* **69**, 69 (1953)).

1866. Kuch, C., **Printing on fabrics of polyamide fibers,*** *Textil-Praxis* **7**, 638–41 (1952).

1867. Kunin, T. I., **Stability of Rongalite,*** *Tekstil. Prom.* **9**, No. 2, 27–30 (1949) (*Chem. Abstracts* **46**, 4236a (1952)).

1868. Michie, A. G. H., **Orthophosphoric acid in the printing of Brentogen and Soledon dyes,** *J. Soc. Dyers and Colourists* **68**, 257 (1952) (Letter to the Editor).

1869. Nijkamp, D. J. E., **Chemical attack upon screen-printed rayon fabrics,** *Rayon Rev.* **5**, 90–7 (1951) (English edition).

1870. Patel, R. B., and Turner, H. A., **Studies in the fundamental processes of textile printing: IV: The transfer of acid dyes to cellulose during steaming,** *J. Soc. Dyers and Colourists* **68**, 77–87 (1952).

1871. Patni, K. K., and Ramachandran, S. R., **Pigment printing,** *J. Sci. Ind. Research* (India) **11B**, 191–7 (1952).

1872. Peake, C. B., **The evolution of the application of pigment colours to textiles,** *Can. Text. J.* **69**, No. 20, 61–4 (1952).

1873. Pouter, J. L., **Peculiarities in printing with vat and azo dyes,*** *Industrie textile* **69**, 339–40 (1952) (*Chem. Abstracts* **47**, 323a (1953)).

1874. Reif, W., **Mechanical theory of print thickenings,*** *Melliand Textilber.* **33**, 532–5 (1952).

1875. Reinartz, K., **The Acramine F process,*** *Melliand Textilber.* **33**, 626–8 (1952).

1876. Schmidt, K., **"Textile printing,"** * Wuppertal-Barmen, Spohr Verlag, 1951, 113 pp. (*J. Text. Inst.* **43**, A245 (1952)).

1877. Schwenk, P., **Protection of printing machine box-wheels,** *Dyer* **108**, 243–5 (1952).

1878. Welcker, P., **Photomechanical preparation of screens for Lyonnaise printing,*** *Teintex* **17**, 101, 103, 105, 107, 109 (1952).

1879. Wolff, A., **Coprantine dyestuffs in direct printing and discharge printing,*** *Teintex* **17**, 449, 451, 453, 455, 457, 459 (1952).

E. Finishing

1. Milling

1880. Anon., **Cloth shrinkage machines,** *Wool Science Rev.*, No. 8, 61–71 (1952).

1881. Höck, H., **The importance of fulling in the cloth manufacturing industry,*** *Melliand Textilber.* **33**, 871–2 (1952).

1882. Hünlich, R., **Alkaline and acidic milling,*** *Melliand Textilber.* **33**, 761 (1952).

1883. Makishima, K., **Theory of milling,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 70–6 (1950) (*Chem. Abstracts* **46**, 5850f (1952)).

1884. Sadov, F. I., and Shikanova, I. A., **The nature of the felting process,*** *Tekstil. Prom.* **12**, No. 7, 36–9 (1952) (*Faserforsch. u. Textiltech.* **3**, 464 (1952)).

1885. Schönwandt, D., **Some faults in the finishing of woolen and worsted fabrics,*** *Tids. Textilteknik* **10**, 40–2 (1952).

1886. Sedgwick, T. H., **Finishing practice: IX: Raising techniques,** *Dyer* **108**, 99–102 (1952).

1887. Whewell, C. S., **Observations on the finishing of fabrics containing wool and other fibres,** in **"The Third Canadian Textile Seminar"** (collected papers), Montreal, 1952, pp. 57–63.

1888. Whewell, C. S., **The teaseling of fabrics of textile fibers,*** *Bull. inst. text. France*, No. 30, 439–50 (1952).

1889. Whewell, C. S., Barrett, P., and Senior, J., **The finishing of fabrics containing wool and man-made fibres,** *J. Text. Inst.* **43**, P648–60 (1952).

2. Crease-Resistant Finishing

(a) Research

1890. Daul, G. C., Reinhardt, R. M., and Reid, J. D., **Crease-resistant cloth from partially carboxymethylated cotton,** TEXTILE RESEARCH JOURNAL **22**, 792–7 (1952).

1891. Hamburger, W. J., Platt, M. M., and Morgan, H. M., **Mechanics of elastic performance of textile materials: X: Some aspects of elastic behavior at low strains,** TEXTILE RESEARCH JOURNAL **22**, 695–729 (1952).

1892. Hida, M., **Crease-resistant finish with urea-formaldehyde resin: I: Influence of resin finish upon the shade and fastness of dyes,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 393–6 (1952) (*Chem. Abstracts* **47**, 874h (1953)).

1893. Hida, M., **Crease-resistant finish with urea-formaldehyde resin: II: Relation between the change in the shade by the resin finish and the structure of direct dyes,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 397–8 (1952) (*Chem. Abstracts* **47**, 874i (1953)).

1894. de Jong, J. I., and de Jong, J., **The reaction between urea and formaldehyde in concentrated solutions,** *Rec. trav. chim.* **71**, 890–8 (1952) (in English) (*Chem. Abstracts* **47**, 955b (1953)).

1895. Mizuta, M., **Treatment of rayon filaments with synthetic resins: I: Dimethylolurea treatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 557–61 (1951) (*Chem. Abstracts* **46**, 4237d (1952)).

1896. Mizuta, M., **Treatment of rayon filaments with synthetic resins: II: Effect of various catalysts in the dimethylolurea treatment,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 602–7 (1951) (*Chem. Abstracts* **46**, 4237d (1952)).

DYEING AND FINISHING

1897. Mizuta, K., **Treatment of rayon filaments with synthetic resins: III: Relation between the synthetic-resin content and the physical properties of rayon filaments,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 70–2 (1952) (*Chem. Abstracts* **46**, 8860i (1952)).

1898. Nuessle, A. C., *et al.*, **Some variables in improving the crease recovery of cotton fabrics with synthetic resins,** *Am. Dyestuff Reptr.* **41**, P196–212 (1952).

1899. Sobue, H., Matsuzaki, K., and Murakami, K., **Improvement of fiber qualities by aftertreatment: I: Crease resistance of rayon,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 241–4 (1952) (*Chem. Abstracts* **46**, 8860h (1952)).

1900. Tsuji, W., and Tomioka, A., **Improvement of fiber quality with synthetic resin treatment: II: Elastic properties of viscose rayon fibers treated with urea resin,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 508–12 (1950) (*Chem. Abstracts* **46**, 6390d (1952)).

1901. Wohnsiedler, H. P., **Urea-formaldehyde and melamine-formaldehyde condensations: Mechanisms,** *Ind. Eng. Chem.* **44**, 2679–86 (1952).

See also [344, 392]

(b) *Development*

1902. Barnard, K. H., **Development of textile resins in 1952,** *Can. Text. J.* **69**, No. 24, 59–62 (1952).

1903. Bernard, J. J., **Finishing with the urea formaldehyde resins,** *Textile Inds.* **116**, No. 8, 118–23 (1952).

1904. Driesch, H., **Experiments on wrinkle-resistant spun rayon fabrics,*** *Rayonne et fibres synthét.* **8**, No. 9, 25, 27, 29–31, 33, 35, 37, 39 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 459–64 (1952).

1905. Fluck, L. A., Keppler, G. J., Cooke, T. F., and Zimmerman, C. L., **Odour prevention in resin treated fabrics,** *Can. Text. J.* **69**, No. 26, 59–63 (1952).

1906. Hagen, F., **Curing machine for fabrics,*** *Melliand Textilber.* **33**, 231 (1952).

1907. Hagen, F., **New machines for synthetic resin finishing,*** *Melliand Textilber.* **33**, 873–5 (1952).

1908. Patterson, D. G., Detwiler, E. B., and Suen, T. J., **Resins as finishing agents,** *Modern Plastics* **29**, No. 7, 151–2, 154, 156, 158, 160, 162, 164, 270, 272, 275 (1952).

1909. Raikhlin, F. I., and Kasatkin, N. M., **Finishing fabrics containing rayon staple fiber,*** *Tekstil. Prom.* **11**, No. 7, 24–6 (1951) (*J. Soc. Dyers and Colourists* **68**, 136 (1952)).

1910. Rath, H., **Methyl amine formation in resin finishing,*** *Textil-Praxis* **7**, 896–7 (1952).

1911. Schönpflug, E., and Anschütz, H., **Stripping of synthetic condensation resins,*** *Melliand Textilber.* **33**, 959–60, 1036–8 (1952).

1912. Schuringa, G. J., and van Bochove, C., **Properties of cellulose fabrics treated with crosslink or resin forming agents,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 329–35 (in English).

1913. Shapiro, L., **Care and storage life of urea-formaldehyde resins and solutions,** *Rayon and Synthetic Texts.* **33**, No. 2, 65, 67–8 (1952).

1914. Swillens, P., **Mechanical and chemical finishing of fabrics made of viscose staple fiber and viscose blended with acetate,*** *Rayonne et fibres synthét.* **8**, No. 1, 34–44 (1952); *Reyon Zellwolle u. Chemiefasern* **30**, 254–60 (1952).

1915. Wardell, W. A., **Stabilization and shrinkage control,** *Am. Dyestuff Reptr.* **41**, P546–9 (1952).

1916. Welch, I. H., and Woodruff, J. A., **Avcoset stabilization of rayon fabrics,** *Am. Dyestuff Reptr.* **41**, P880–4 (1952).

(c) *Analysis and Testing of Treated Fabrics*

1917. Elöd, E., and Graeser, W., **Crease resistant finishing: Estimation of the degree of condensation of aminoplasts,*** *Reyon Zellwolle u. Chemiefasern* **30**, 515–24 (1952); *Rayonne et fibres synthét.* **9**, No. 1, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45–8 (1953).

1918. Gurley, M. H., Jr., *et al.*, **Instruments for measuring crease resistance,** *Am. Dyestuff Reptr.* **41**, P419–23 (1952).

1919. Kramer, M., and Graeser, W., **Detection of synthetic resins in crease-proofed viscose rayon with Tollens reagent and Kiton Pure Blue V,*** *Melliand Textilber.* **33**, 226–9 (1952).

1920. Kündig, S., **The analysis of cellulose fibers impregnated with urea-formaldehyde and melamine-formaldehyde resins,*** *Textil-Rundschau* **7**, 451–64, 501–27 (1952).

1921. Margolin, I. S., **Determination of the crease resistance of fabrics,*** *Tekstil. Prom.* **12**, No. 5, 35–7 (1952); *Faserforsch. u. Textiltech.* **3**, 459–60 (1952).

1922. Nickerson, R. F., **An investigation of urea-formaldehyde fixation on viscose rayon,** *Am. Dyestuff Reptr.* **41**, P482–6 (1952).

1923. Sommer, H., **Crease properties of fabrics,*** *Melliand Textilber.* **33**, 301 (1952).

1924. Vale, K. G., and Gantz, G. M., **Performance of urea-formaldehyde monomers as a function of age,** *Rayon and Synthetic Texts.* **33**, No. 3, 42, 45–6 (1952).

1925. Wannow, H. A., **Determination of melamine resins in cellulosic fibers and fabrics,*** *Melliand Textilber.* **33**, 758–61 (1952).

1926. Zart, A., **Determination of crease angle for textile structures,*** *Melliand Textilber.* **33**, 40 (1952).

See also [1125]

3. *Flameproofing*

1927. Bernard, K. H., **A review of flame-resistant treatments,** *Am. Dyestuff Reptr.* **41**, P134–5 (1952).

1928. Church, J. M., **"Fundamental studies of chemical retardants for the fire resistant treatment of textiles,"** Textile Series Report 38, U. S. Office of the Quartermaster General, 1952, 299 pp.

1929. Dolan, J. E., **The effect of sodium bicarbonate on the combustion of cellulosic materials,** *Chemistry & Industry* **1952**, 368–71.

1930. Horigan, F. D., and Sage, C. R., **"The flameproofing of fabrics,"** Bibliographic Series No. 18, Philadelphia, U. S. Quartermaster Research and Development Laboratories, 1951, 47 pp.

1931. National Fire Protection Association (Committee on Flameproofing and Preservative Treatments), **"Standard for flameproofed textiles,"** Boston, National Fire Protection Association, 1951, 22 pp. (reviewed in TEXTILE RESEARCH JOURNAL **22**, 439 (1952)).

1932. Puig, J. B., **Flameproofing fabrics of cotton, rayon, and other cellulosic fibers by pretreatment with alkanolamine sulfamates,*** *Bull. inst. text. France*, No. 30, 405–14 (1952).

1933. Quehl, K., **Impregnating fabrics for weather resistance, washability, flame resistance, and waterproofness and test methods for these properties,*** *Melliand Textilber.* **33**, 1115–16 (1952); **34**, 69–71, 143–5 (1953).

1934. Tamaru, K., **Pyrolysis and combustion of cellulose in the presence of inorganic salts,** *Bull. Chem. Soc. Japan* **24**, 164–8 (1951) (in English) (*Chem. Abstracts* **47**, 305e (1953)).

See also [54, 55, 166]

4. *Fabric Setting*

1935. Brierley, S., **Cloth setting reconsidered,** *Textile Manufacturer* **78**, 349–51, 431–3, 449–53, 533–7, 595–7, 653–5 (1952).

1936. Fourné, F., **High-temperature setting of fully synthetic fibers,*** *Melliand Textilber.* **33**, 639–43, 753–7 (1952).

1937. Mecklenburgh, G. K., Shaw, S., and Peters, H. W., **Some developments in the setting and finishing of nylon textiles,** *J. Soc. Dyers and Colourists* **68**, 381–91 (1952).

1938. Noorlander, F., and Nijkamp, D. J. E., **The heat-setting of woven and knitted Enkalon fabrics,** *Rayon Rev.* (special Enkalon issue), 64–6 (1952) (English edition).

5. *Shrinkproofing Wool*

1939. Azuma, N., Bekku, F., and Ito, T., **Shrinkproofing woolen goods: II: Effect of the thiourea-formaldehyde resin treatment on wool,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 449–51 (1951) (*Chem. Abstracts* **46**, 5322g (1952)).

1940. Azuma, N., Bekku, F., and Ito, T., **Shrinkproofing woolen goods: III: Treatment with thiourea-formaldehyde resin and the change of elasticity of wool,*** *J. Soc. Textile Cellulose Ind.* (Japan) **8**, 127–30 (1952) (*Chem. Abstracts* **46**, 8861g (1952)).

1941. Azuma, N., Bekku, F., and Tonami, H., **Shrinkproofing woolen goods: I: Treatment with thiourea-formaldehyde resin,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 162–5 (1951) (*Chem. Abstracts* **46**, 5322f (1952)).

1942. Davidson, A. N., **Some problems associated with the production of washable wool fabrics and garments,** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 41–55 (in English).

1943. Earland, C., and Johnson, K. G., **The treatment of wool with sodium chlorite,** TEXTILE RESEARCH JOURNAL **22**, 591–8 (1952).

1944. Frölich, H. G., **Processes for decreasing the shrinking and felting tendencies of wool,*** *Textil Praxis* **7**, 292–4 (1952).

1945. Makishima, K., and Sasano, H., **Mechanical properties of textile fibers: I: Stress-strain relation of wool treated against shrinkage,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 159–61 (1951) (*Chem. Abstracts* **46**, 5848g (1952)).

1946. van Overbeke, M., **Shrink-proofing treatments for wool,*** *Teintex* **17**, 481–2, 485, 487–8, 491, 493–4 (1952).

1947. Weber, R., Jr., **Practical aspects of the action of hypochlorite on woolen yarn,*** *SVF Fachorgan Textilveredl.* **6**, 67–9 (1951) (*Chem. Abstracts* **46**, 4804c (1952)).

1948. Weiner, L. I., and Rizzo, F. J., **"An educational order trial on 10.5-ounce shrink resistant wool flannel shirting,"** Textile Series Report 76, U. S. Office of the Quartermaster General, 1952, 23 pp.

1949. Wood, F. C., **Non-felting wool and wool mixtures,** *J. Soc. Dyers and Colourists* **68**, 485–95 (1952).

See also [1950]

6. *Finishing with Rubber Latices*

1950. Azuma, N., Bekku, F., and Sayama, Y., **Processing wool with rubber: I: Application of rubber latex,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 615–18 (1951) (*Chem. Abstracts* **46**, 4238h (1952)).

1951. Azuma, N., Bekku, F., and Sayama, Y., **Processing wool with rubber: II: Properties of rubber-coated wool,*** *J. Soc. Textile Cellulose Ind.* (Japan) **7**, 618–19 (1951) (*Chem. Abstracts* **46**, 4238i (1952)).

1952. IAbko, IA. M., and Voiutskii, S. S., **Impregnation of fabrics with synthetic latices,*** *Tekstil. Prom.* **11**, No. 7, 26–7 (1951) (*J. Soc. Dyers and Colourists* **68**, 136 (1952)).

1953. Valtier, E., **Xetal-50: A positive rubber latex,*** *Rev. gén. caoutchouc* **28**, 309–12 (1951) (*Chem. Abstracts* **45**, 8795g (1951)).

1954. Valtier, E., **Xetal-50 and its industrial applications,*** *Rev. gén. caoutchouc* **29**, 398–405 (1952) (*Chem. Abstracts* **46**, 8885c (1952)).

7. *Miscellaneous*

1955. Aenishänslin, R., **Application of synthetic resins in textile finishing,*** *SVF Fachorgan Textilveredl.* **6**, 136–44 (1951) (*J. Text. Inst.* **43**, A247 (1952)).

1956. Albrecht, O., **Synthetic polymers, especially the acrylic series, for the textile industry,*** *Textil-Rundschau* **7**, 401–11 (1952).

1957. Arnold, H., **Testing of water-repellent properties of rain-coat materials,*** *Melliand Textilber.* **33**, 322–3, 429–30 (1952).

1958. Blow, C. M., and Pike, M., **Water-vapour permeable natural-rubber proofed fabrics,** *Rubber Developments* **5**, No. 2, 60–4 (1952) (*Chem. Abstracts* **46**, 11748c (1952)).

1959. Defalque, F., **Some permanent sizings,*** *Industrie textile* **68**, 86–92, 140–2 (1951) (*Chem. Abstracts* **46**, 4806b (1952)).

1960. Dutt, M. C., **Calendering of textiles and calender bowls,** *Indian Text. J.* **63**, 106–12 (1952).

1961. Edelstein, S. M., **New effects possible with substantive softener that works with anionics,** *Textile Age* **16**, No. 1, 34–5 (1952).

1962. Fabrini, E., **Mineral weighting of silk,*** *Textil-Praxis* **7**, 70–3 (1952).

1963. Götze, K., **Fifty years of textile auxiliaries,*** *Melliand Textilber.* **33**, 51–7, 147–52 (1952).

1964. Grimshaw, E. P., **The properties and applications of synthetic water-soluble polymers,** *Plastics Inst.* (London) *Trans.* **20**, No. 42, 9–42 (1952) (*Chem. Abstracts* **47**, 1973i (1953)).

1965. Harris Research Laboratory, **"Quartermaster research on water resistant textiles,"** Textile Series Report 37, U. S. Office of the Quartermaster General, 1952, 186 pp.

1966. Jahn, F. W., **Methylcellulose and carboxymethylcellulose: Critical considerations and practical hints for the finisher,*** *Textil-Praxis* **7**, 299–302 (1952).

DYEING AND FINISHING

1967. Kärrholm, E. M., **Testing of water-repellency,** *J. Text. Inst.* **43**, P263–89 (1952).

1968. Landolt, A., **The application of some synthetic resins in the textile industry,** *J. Text. Inst.* **43**, P331–40 (1952).

1969. Meyrick, T. J., and Watts, J. T., **Polyisocyanates in bonding: I: Terylene polyester fiber to rubber,** *India-Rubber J.* **122**, 467–8 (1952) (*Chem. Abstracts* **46**, 6423b (1952)).

1970. Musset, C., **The shrinkage of cellulosic fabrics,*** *Industrie textile* **69**, 103–7 (1952) (*Chem. Abstracts* **46**, 6393f (1952)).

1971. Normand, C., **Improved comfort by diminishing the coefficient of friction of wet vegetable fibers,*** *Industrie textile* **69**, 271–3 (1952) (*Chem. Abstracts* **46**, 11691c (1952)).

1972. Ploenes, H., **Embossing of woven fabrics,*** *Melliand Textilber.* **33**, 1114–15 (1952); **34**, 65–7 (1953).

1973. Scott, W. M., **Trends in the chemical processing of cotton fabrics,** *Am. Dyestuff Reptr.* **40**, P473–6 (1951).

1974. Segall, G. H., **A theory of water-resistant fabrics,** TEXTILE RESEARCH JOURNAL **22**, 736–41 (1952).

1975. Serchi, G., and Chini, P., **Water repellency: I: Mechanical theory of the wetting ability of a fabric under the action of the rain,*** *Chimica* (Milan) **7**, 43–55 (1952) (*Chem. Abstracts* **46**, 7774c (1952)).

1976. Speel, H. C. (editor), **"Textile chemicals and auxiliaries,"** New York, Reinhold Publishing Corp., 1952, 493 pp.

1977. Starck, W., **Polyvinyl acetate and its derivatives as a basis of auxiliary products for the textile industry,*** *Melliand Textilber.* **33**, 944–6 (1952).

1978. Trevor, J. S., **Lithium compounds and their possible application for textile processing,** *Textile Recorder* **69**, No. 827, 91 (1952).

1979. Tsuritani, T., **Dropping phenomenon of water drop on cloths: I: Vertical dropping,*** *J. Soc. Textile Cellulose Ind.* (Japan) **5**, 353–6 (1949) (*Chem. Abstracts* **46**, 4240d (1952)).

1980. Walmsley, L. L., **Finishing of acetate tricot fabrics,** *Can. Text. J.* **69**, No. 12, 68–70 (1952).

1981. Wirth, P., **Crinkled crepe,*** *SVF Fachorgan Textilveredl.* **7**, 41–9 (1952) (*Chem. Abstracts* **46**, 5323g (1952)).

F. Drying

1982. Alexander, P., and Meek, G. A., **Application of dielectric heating and drying in the textile industry,*** *Melliand Textilber.* **33**, 163–6, 229–30 (1952).

1983. Coles, W. V., **Continuous drying of viscose staple fiber,** *J. Inst. Fuel* **25**, 60–5 (1952) (*Chem. Abstracts* **46**, 4237e (1952)).

1984. Dunski, C. V., **Drying of fabrics by infrared radiation: Present and future possibilities,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 349–91 (in French).

1985. Goldmann, H., **Drying yarn, etc., in packaged form,** *Textile Manufacturer* **78**, 40–2 (1952).

1986. Gralén, N., and Werner, G., **Motion of water vapor through textiles,*** *Bull. inst. text. France,* No. 30, 379–86 (1952).

1987. Haas, H., **Heat theory observations on drying with superheated steam,*** *Melliand Textilber.* **33**, 346–9 (1952).

1988. Lincoln, B., **Wool drying problems: Improving output by methods of air flow,** *Text. J. Australia* **26**, 1106–7, 1176–7 (1952).

1989. Mulsow, R., **Heating efficiency and evaporation figures of high-performance driers,*** *Melliand Textilber.* **33**, 1117–19 (1952).

1990. van Nes, R., **High-frequency drying in the rayon industry,** in **"Symposium on the Physics of Fibrous Materials"** (collected papers), Arnhem, Holland, 1950, pp. 95–103; *Rayon Rev.* **5**, 16–23 (1951) (English edition).

1991. Peck, R. E., Griffith, R. T., and Rao, K. N., **Relative magnitudes of surface and internal resistance in drying,** *Ind. Eng. Chem.* **44**, 664–9 (1952).

1992. Preston, J. M., **The elimination of water from textiles,*** *Bull. inst. text. France,* No. 30, 467–75 (1952).

1993. Preston, J. M., and Gundavda, S. P., **Some aspects of the drying and heating of textiles: VII: The stability of thermal modifications of fibres in subsequent treatments,** *J. Soc. Dyers and Colourists* **68**, 511 (1952).

1994. Selling, H. J., **Application of infrared drying in the textile industry,*** in **"International Congress of Sciences Applied to the Textile Industry"** (collected papers), Ghent, 1951, pp. 339–47 (in Dutch).

1995. Westbrook, F. A., **Infra-red heaters for textile drying must be properly selected,** *Textile Age* **16**, No. 6, 52–4 (1952).

1996. Wingard, R. E., and Rozier, W. H., **Comparative drying rates—Infrared *versus* hot air,** *Alabama Polytech. Inst. Bull.* **47**, No. 4; *Eng. Expt. Sta., Eng. Bull.*, No. 15, 3–14 (1952) (*Chem. Abstracts* **46**, 6870h (1952)).

1997. Yamamoto, I., Uchida, H., Aoki, A., Tominaga, I., and Hasumi, S., **Drying of cotton yarn by high-frequency waves,*** *J. Soc. Textile Cellulose Ind.* (Japan) **6**, 36–41 (1950) (*Chem. Abstracts* **46**, 4237g (1952)).

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% Length Recovery from Stretch	5% stretch	67	65	66	70
	20% stretch	31	35	34	37
% Work Recovery	5% stretch	44	47	46	51
	20% stretch	17	17	15	18
Work to Stretch 10^6 ergs/cm^3	5% stretch	24	23	24	20
	20% stretch	136	145	143	157
Young's Modulus g/den/per cent		.24	.25	.27	.33
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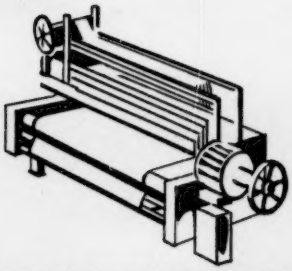

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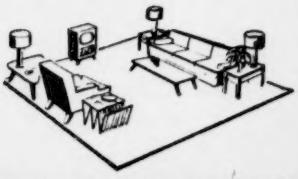

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